E ENGINEERING MAGAZINE OF THE METAL-WORKING INDUSTRIES

ENGI..ERING

METALS and ALLOYS

ATERIALS AND DESIGN · **METHODS** AND PROCESSES · **APRIL, 1945**

. . and on the home-front

WAR NEWS
POLAND INVADED
THE NEWS
DUNKERQUE!
THE NEWS
PEARL HARBOR!
WAR NEWS
MANILA LOST
WAR NEWS
MUSSOLINI OUT
WAR NEWS
D-DAY
B&W K-20
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METALS and ALLOYS

The Engineering Magazine of the Metal-Working Industries

VOLUME 21 • NUMBER 4 • APRIL, 1945

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Published Monthly by Reinhold Publishing Corporation, 330 West 42nd St., New York (18), N. Y., U.S.A. Ralph Reinhold, President and Treasurer; H. Burton Lowe, Vice President and Secretary; Philip H. Hubbard, Vice President; Francis M. Turner, Vice President; William P. Winsor, Vice President; G. E. Cochran, Vice President. Price 25 cents a copy. Annual Subscription: U. S., Possessions and Canada, $2.00. All Other Countries, $3.00. (Remit by New York Draft.) Copyright, 1945, by Reinhold Publishing Corporation. All rights reserved. Entered as second class matter Aug. 16, 1944, at the Post Office at New York, N. Y., under the Act of March 3, 1879.

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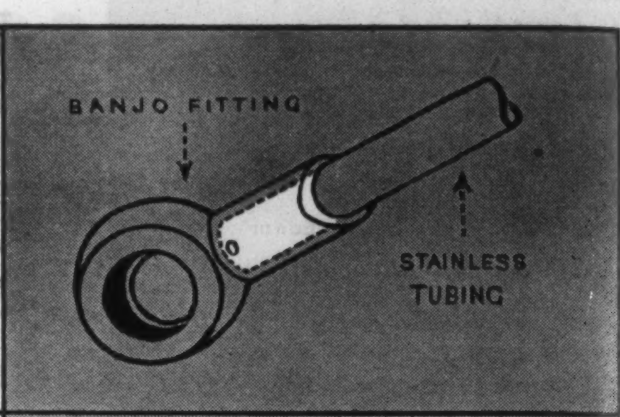
The May issue of METALS AND ALLOYS will feature a Materials and Methods Manual on Heat Treatment, plus articles on Blackened Stainless Steels, Zinc Alloy Forming Dies, Electrical Contacts, Flame Cutting Methods, Vacuum Casting of Electronic Parts, Magnesium vs. Coastal Exposure, etc.

FUNDAMENTALS *and* APPLICATIONS OF INDUCTION HEATING

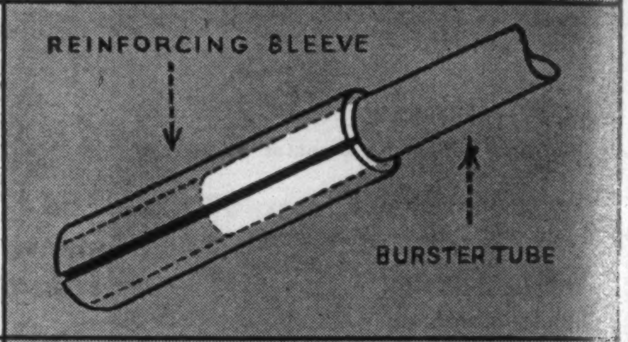
INDUCTION HEATING CORPORATION
NEW YORK CITY

Case Histories: Brazing Applications — **Data Sheet No. 13**

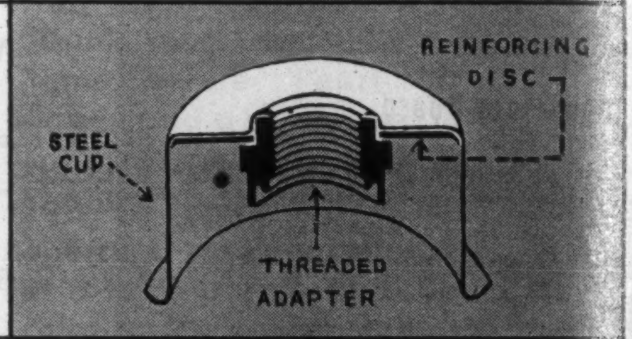
Job: To braze banjo fittings and tubing for aircraft engine oil lines.
Material: Stainless steel.
Production: 14 assemblies every 65 seconds.
Equipment: One model 1070 or 520 Thermonic induction generator and 2 position table.
Remarks: 1/32" dia. or 3/64" dia. wire silver brazing alloy, depending on fit. Because of the critical requirements, these parts are 100% X-ray inspected. Brazing time has purposely been increased to produce perfect shear area brazes.



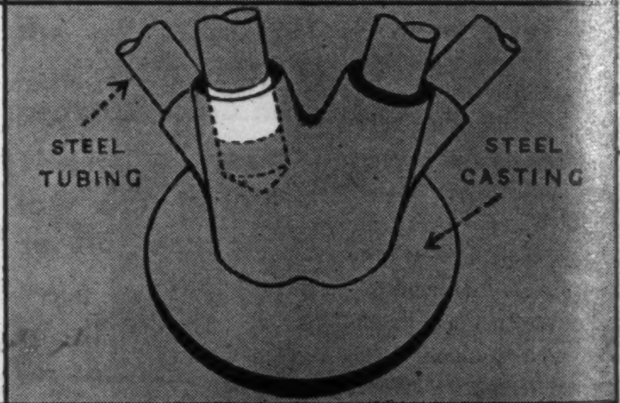
Job: To silver braze a reinforcing sleeve to a burster tube.
Material: SAE 1010 steel tubing.
Production: 8 every 35 seconds.
Equipment: One model 1070 Thermonic induction generator and 2 position table.
Remarks: Alloy flowed 1/2" of shear area using 1/16" dia. wire silver brazing alloy ring.



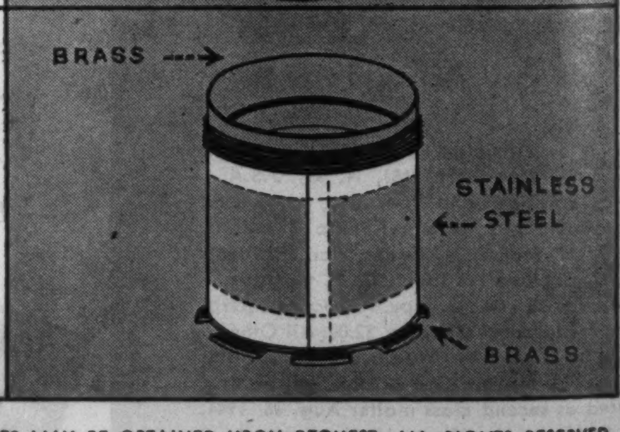
Job: To silver braze a threaded adapter to the tail cup of a M74 bomb.
Material: SAE 1010 steel.
Production: 5 every 40 seconds.
Equipment: One model 1070 Thermonic induction generator and 2 position table.
Remarks: 2 rings of 1/16" dia. wire silver brazing alloy used.



Job: To silver braze tubes to tripod base.
Material: SAE 1010 tubing and steel casting.
Production: 2 tubes every 60 seconds.
Equipment: One model 1070 Thermonic induction generator, a turntable and single turn split coil.
Remarks: 3/32" dia. wire silver brazing alloy ring used . . . resulting in a flow of 2/3rds of shear area.



Job: To braze an extension assembly of a thermostatic extension valve.
Material: 2 brass fittings and stainless steel tube.
Production: 2 complete assemblies every 50 seconds.
Equipment: One model 520 Thermonic induction generator and a 2 position table.
Remarks: 2 rings of 1/16" dia. silver brazing alloy used. The open seam of the spot welded, stainless steel formed tube, was completely sealed simultaneously with the brazing of the 2 brass fittings.



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THIS IS DATA SHEET NO. 13. IT CONTINUES THE CASE HISTORY SERIES OF THERMONIC APPLICATIONS, MANY OF WHICH MAY HELP SOLVE YOUR PROBLEMS, POST-WAR.

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Largest Producers of Electronic Heat Treating Equipment for brazing • melting • hardening • forging • annealing

EDITORIALS

Battlefield Scrap is Good Scrap

One of the most valuable features of the N.E. steels is that, being largely based upon three alloying elements, they permit the use of alloy steel scrap and full utilization of the high-priority alloying elements it contains. Batches of scrap containing steels of varying alloy content, not always separable to such a degree as to permit making of the bi-alloy steels without excessive contamination by a third metal, can be melted down and brought to the desired composition by the proper addition.

As the war progresses, and especially as the enemy retreats, there comes into our hands an increasing amount of scrap from the battlefields—both our own wrecked equipment and the enemy's. The steel used is generally of a high quality, and the amount of alloying metals contained is great enough to be an important factor in our requirements. Battlefield scrap, melted down and re-alloyed to our triple-alloy steel compositions, is as much a part of our war production as the Mesabe iron ores, the Detroit manufacturing plants, or the Pacific coast shipyards.

During World War I the use of brass cartridge cases as scrap metal ran into difficulties because of contamination of the metal by antimony and mercury from the explosives. This problem does not occur in the use of scrap steels. The steels are made up to a standard composition, and frequently to specified physical properties, so that any contamination of significant amount is easily detected.

There have been reports of difficulties with some of the early lots of battlefield scrap to reach this country. Exploding ammunition, not discovered in lots of heavy scrap, is said to have caused damage. At present the army is overseeing the segregation of battlefield scrap to prevent repetition of any such occurrences.

—K. R.

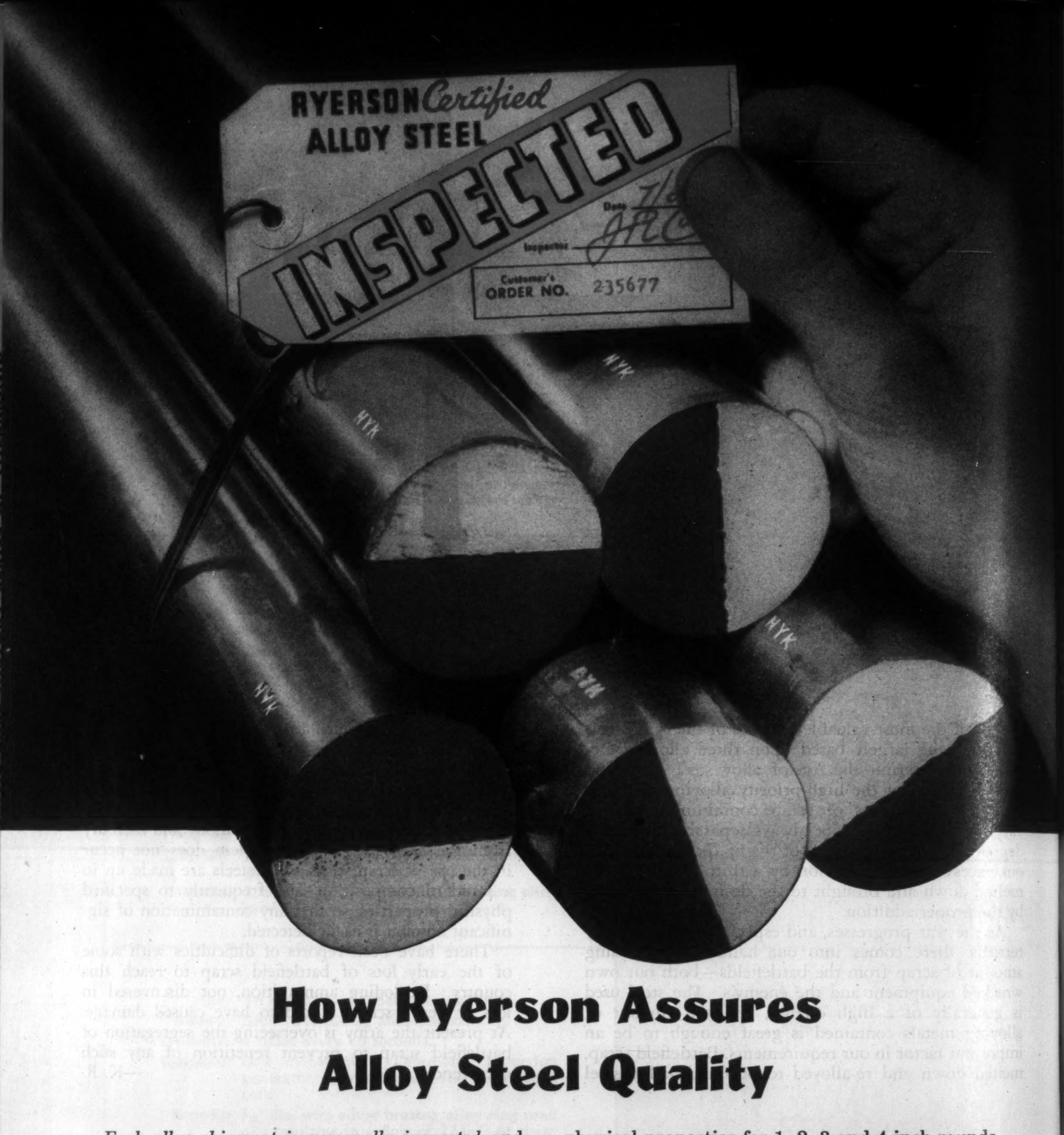
Shall Aliens Visit Our Plants?

When the war is over are we going to allow steel and metal producers from the Axis powers or others to visit our plants, as in pre-war days? Our own answer is an emphatic "No!" We didn't like the "Uncle Sap" role for Uncle Sam in the old days. Now we are inclined to say: "We told you so." Back in those days on another publication we wrote an editorial questioning the wisdom of allowing foreigners to inspect our industrial plants. But our editorial was never published on the grounds that it might inflame international relations.

More recently we were reminded of those foolish halcyon days when we read a piece in *Copper Commando,* house organ of the Anaconda Copper Mining Co., reminiscing on how Japanese industrialists visited all Anaconda plants in Montana with toothy smiles and notebooks. They wore out their notebooks and continued to wear their smiles. The house organ concludes that had the Jap succeeded in establishing themselves on our Pacific Coast it would not have been long before they bombed out the Anaconda plants—and they would have known precisely where to lay their eggs!

All of which reminds us of a story we never tire of telling.

The late and genial Charles M. Schwab was perhaps sometimes a bit too genial for the country's good. A delegation of Japanese industrialists called on him and after wining and dining them, he wrote a letter of introduction "to all it may concern." Armed with



How Ryerson Assures Alloy Steel Quality

Each alloy shipment is personally inspected and tagged as a part of a rigid quality control system, which we call the Ryerson Certified Steel Plan. This plan covers: selection of the individual heats of alloy steel, the testing of samples from each heat, the positive identification of every alloy bar with stamped heat symbol and painted color markings (or with metal tags), and a Ryerson Alloy Steel Report, which is sent with each shipment. This report shows complete test information for the particular heat of steel used in filling your order. It contains: chemical analysis, recommended working temperatures, the Jominy hardenability results, and an interpretation of physical properties for 1, 2, 3 and 4 inch rounds quenched and drawn at 1000°, 1100° and 1200° F. The report serves as positive identification, a check on quality and as a guide to satisfactory heat treatment.

The Ryerson Inspection Tag symbolizes the final culmination of our quality controls, because it places a personal responsibility on us for the fulfillment of every specification in your order. This is the Ryerson way of making sure that you get the right steel. Ryerson alloys all receive the same systematic care. Call Ryerson for alloy steels, or for any other type of steel, and be assured of uniform quality and prompt action.

RYERSON STEEL

Joseph T. Ryerson & Son, Inc., Steel-Service Plants: Chicago, Milwaukee, Detroit, St. Louis, Cincinnati, Cleveland, Pittsburgh, Philadelphia, Buffalo, New York, Boston.

this letter the Japs visited many steel and metal plants —for what was good enough for Charlie Schwab was good enough for the average plant owner or manager.

One day they arrived at a plant in the Pittsburgh district where they made a steel specialty, a most modern and valuable product. The assistant superintendent agreed to conduct them through the plant. They had not progressed far when the guide noticed they were taking pictures. The small lens was in a buttonhole in a Jap lapel, with the bulb and camera mechanism in his coat pocket.

The guide thought quickly. When the opportunity arose he phoned to headquarters explaining the situation and saying: "We will be in the forge department in 10 minutes. Fake a terrific explosion." So when on schedule they reached the forges, all Hell broke loose. All hammers dropped simultaneously; steam valves were turned open and a crane operator dropped a load of scrap.

The guide grabbed the Japs and rushed them out of the plant to "safety." With legs wabbling and cold sweat on foreheads they had no relish for further plant inspection that day.

No, it will be many years, if ever, when we again welcome Axis industrialists into our manufacturing plants!

—H. A. K.

Strain Sensitivity and Strain Gages

We wonder how many of our readers are aware of the important wartime uses to which has been put one of our most rarefied and mysterious properties of metals—strain sensitivity—and the effect its applicability may ultimately have on general engineering and structural design. We know that *we* were personally surprised at the extent of its influence, as outlined with characteristic clarity by Dr. A. V. de Forest of M.I.T. to the highly successful first meeting of the Metal Science Club of the Metropolitan New York and New Jersey area last month.

Strain sensitivity, most simply (perhaps *too* simply) expressed, is the change in electrical resistance of a metal when strained, the change being different from that due solely to modification of dimensions. Strain sensitivity is a characteristic property; some metals (*e.g.* constantan, a 55 Cu, 45 Ni alloy) possess it to a marked degree, whereas others have it to a minor extent only.

The important application of the property today is in the electric strain gage, which comprises (usually) a filament of constantan wire embedded in a thermosetting plastic. Leads from the wire are connected to an accurate resistance measuring device, and the gage is affixed to the surface of the structure or component under test. Strain may be measured locally or generally, under static stress or under dynamic stress, or in various directions, by using a multitude of gages—and either right at the structure or remotely by ingenious electronic-oscillographic systems. In fact, some truly astonishing data are being obtained about the strains on vital parts of aircraft while they are in flight by observers sitting comfortably in test rooms on the ground watching and recording oscilloscopic curves "broadcast" by the strain gage system on the plane.

Such strain gages are used to observe and study the design and operating stresses on various types of structures from bridge girders and ship sections to turbine blades. Without the unfamiliar property of strain sensitivity, these uses would be impossible, yet even among the strain-sensitive materials now in use there is no ideal. Some of them have too high a temperature coefficient of strain sensitivity. Others have too high a temperature coefficient of electrical resistance, which interferes with the strain sensitivity measurements. Some of the materials are structurally unstable.

The engineering uses of strain sensitivity are certain to be broadened as we learn more about the property and find alloys perhaps at present unknown that possess it to a marked degree.

—F.P.P.

Since the above editorial was written, we have learned of the death (on April 5th) of Professor de Forest—news that will come as a saddening blow to his numberless friends and admirers among our readers.

The Steel Industry's Achievement

"It can't be done!" In those hectic days of 1940, when active preparations were being made to ward off the German menace to this country and continent by aid to Great Britain, it became evident that our steelmaking and blast furnace capacity would have to be increased. Many were the protests that this was either unnecessary or that it could not be done. Estimates of an expansion of about 10,000,000 net tons in both steelmaking and blast furnace capacity were made. It was predicted that to do this and keep up capacity output would be impossible. But a program of expansion on the 10,000,000-ton scale was inaugurated.

It has been done! According to data of the American Iron and Steel Institute, the steelmaking capacity as of Jan. 1, this year, has been increased since Jan. 1, 1940 by over 13,750,000 tons and stands at about 95,500,000 tons of ingots and steel for castings per year, and that the blast furnace capacity in the same period has been expanded more than 11,500,000 tons and stands at about 67,300,000 tons per year of pig iron and ferroalloys. Thus, the estimated needs of 1940 have been more than exceeded in 5 years. This brings to a virtual conclusion a tremendous emergency expansion program, once pronounced visionary and impossible.

An idea of the scope of this expansion is afforded by a cursory analysis of the statistics. At the same time that this increase of about 17% in steelmaking capacity and of about 20.7% in pig iron capacity was being inaugurated, the output of steel and pig iron furnaces rose approximately 33.7% and 30.6% respectively by the close of 1944—an impressive demonstration of cooperative engineering effort.

It can truly be said that the sharp expansion of capacity is a program which "ranks among the greatest industrial constructive undertakings of all time." We heartily subscribe to this and proudly congratulate the American steel industry.

—E.F.C.

ORE
COAL
LIMESTONE

Finer Things
Are Coming Out of the Ground

From the ore ranges, the coal fields, and the limestone beds are coming vast quantities of blended iron ore, coking coal, and purest limestone—the principal ingredients for making steel, the "master metal" in both peace and war.

Today this steel must all go into the production of the materiel of war, but tomorrow, when Victory is ours, finer things will come to us from out of the ground because of improvements now being made in steel.

Inland metallurgists are constantly testing and re-testing, melting and re-melting, adding one element and taking away another—always seeking for something better. Already they have contributed many new methods and new steels to production for war.

These, and the newer methods and Inland steels that are sure to come from continued intensive research, will help you meet the needs of America at peace.

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Materials Specifications

an Editorial

Although many engineers were aware of the problem long before the war, the emergency period has thrown into sharp and general relief the hopeless inadequacy of a large number of our materials specifications, and especially of our usual specification-writing philosophy and practice, from the Government on down to the smallest shops.

Too many Army and Navy specifications, for example, were written many years ago and fail to reflect advances in materials engineering, in our knowledge of specific mechanical properties or in our understanding of representative sampling and inspection procedure. Even some that are being currently written perpetuate the errors of the past through lack of imagination or information on the part of the specification writer or through ultra-conservatism on the part of the brass hats involved. And the same fallacies that run through some government specifications also crop up in manufacturers' specs to plague the engineer, production man or metallurgist who must meet or interpret them.

The waste, confusion and misapplication that can result from silly specifications is appalling, and virtually every reader can think of some instance that has either amused or shocked him—the latter when the item is a critical product or one that is in large-scale production. For example one Service has a casting specification that applies without change to bars of all sizes from 2 to 8 in., completely ignoring the considerable difference in properties obtained with different casting-section thicknesses. Others are too specific in permitting only the use of a single composition or proprietary brand of material.

Indeed, the fundamental objections to many poor specifications is their age and the fact that they are based on analysis or even on physical properties as conventionally tested rather than on the much more significant service requirements of the job and the service properties of the material. Thus, many ductility clauses are known to be meaningless in view of the particular service involved. Analyses are often rigidly specified that were satisfactory 20 years ago but which are far from the best available today.

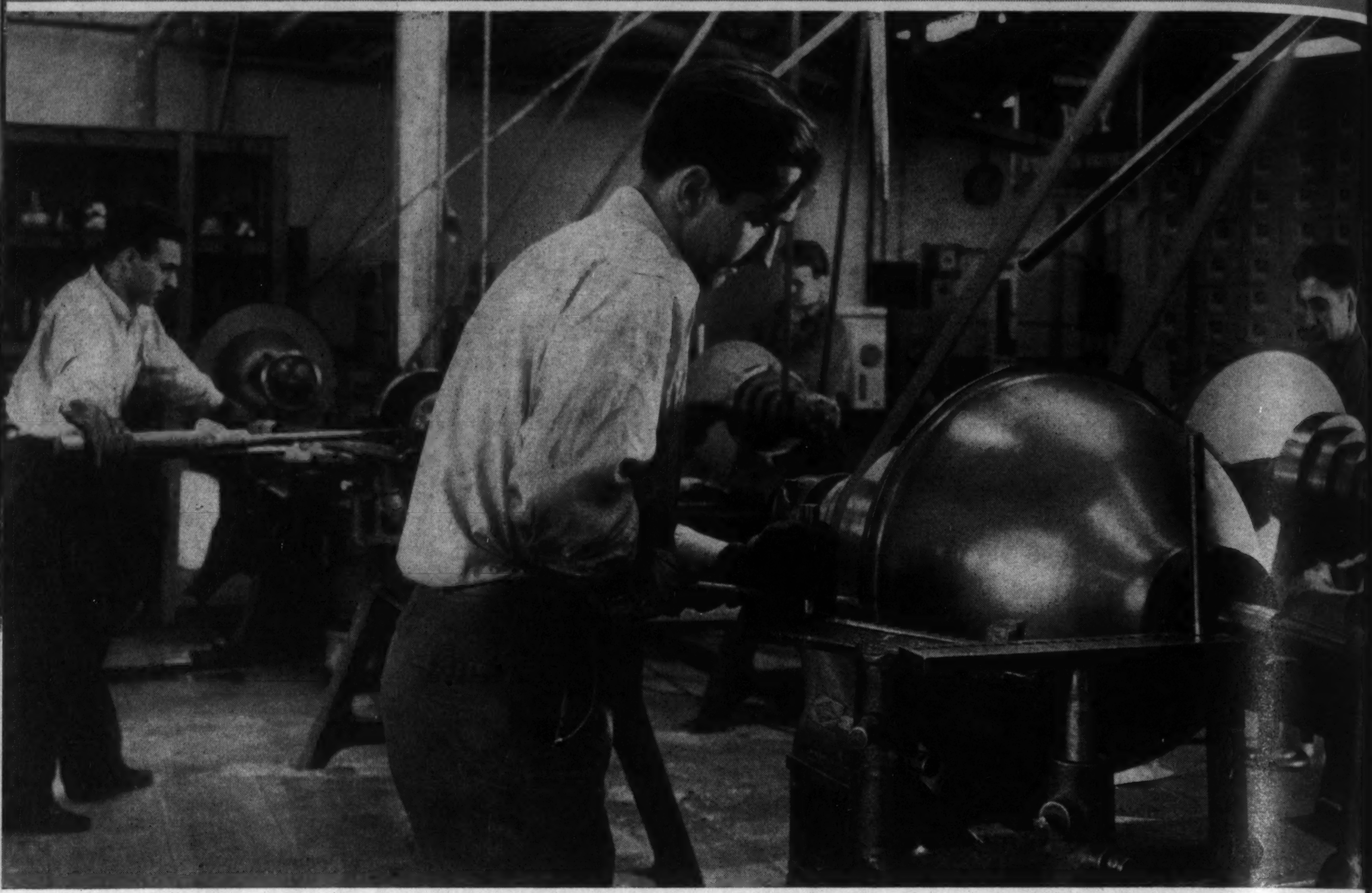
A very common failing is the wasteful insistence on more quality in the material or product than is necessary. This often takes the shape of requiring greater mass or thickness in a casting (usually iron) than would have been specified if the original specification writer had known about today's higher-strength irons or other materials. Too great a factor of safety (or "factor of ignorance," as you please) is just plain poor engineering.

The use of loose or non-descriptive or ambiguous terminology like "drill rod," "carbon steel," "chrome-moly steel," "cast iron," "brass," "plastics" without pinning it down to a quality or service-performance level is a non-specific specification and sure to cause pain and unhappiness to someone, just as much as does the specification that is too rigid in its designation. Many other examples and cases of poor specification-writing could be cited.

What is most needed is a general and continuing revision of all our specifications that have their roots in ground more than 5 years old and, in the writing of new specifications, utilization of a sense of true engineering values coupled with exact and up-to-date knowledge of the properties of modern materials. This is intelligent specification-writing—one of today's greatest engineering needs.

FRED P. PETERS

A Materials Article Virtually a new type of engineering material with lightness-and-strength combinations that make them competitive with many metals, plus availability as tubing, formable sheet, moldable plastics, etc., the modern woods are attracting increasing attention among engineers and product designers. Today's varieties, their characteristics and manifold uses are described by Mr. Cady.



Special wood forms are used in spinning metals into bowl- or dome-like shapes, as in this steel-spinning operation at Curtis Lighting, Inc.

Wood as an Engineering Material

By EDWIN LAIRD CADY

WOOD IS THE ONE seemingly inexhaustible raw material. Our forests contain over 1,760,000,000,000 board feet of the kinds considered useful for lumber. Of this only 2% is being cut in each war year—the forests have 50 years at that rate to grow this back.

Furthermore, new processes are getting more out of the trees we do cut. A mechanical barker reduces by as much as 16% the wastage of each log. Normally, two-thirds of each tree goes to saw dust and other waste. But the hydrolized wood process (of which Masonite is the best known product) makes use of much of this waste, turns it into pressed wood lumber. Add to these savings the fact that the new resin impregnation processes can make 80% of the kinds of trees useful for lumber as compared to the 1% useful in the past, and it becomes apparent that far smaller acreages of trees are going to yield far more of useful lumber in the near future.

To this plentiful supply is added a second advantage. Modern processing and gluing methods make wood one of the most controllable of raw material bases. Wide ranges of combinations of tensile, shear, compressive and other strengths can be found or created in it. Resistance to impact, abrasion, fire, water, chemicals, etc., can be had to predetermined degrees. Resilience, coefficient of friction, coefficient of thermal expansion, stiffness, stability to hold its shape after being bent or formed—all are within control. Different parts of a wood structure or of a single piece of wood can be given different mechanical or chemical properties.

Modern Woods

Curtiss-Wright's Robert W. Hess has recently reviewed in *Tropical Woods* the remarkable processing strides that are making of wood an increasingly important engineering material. The most noticeable recent developments have occurred in plywood. Highly stressed three-ply 1/32 in. thin skins of a 400-mile-per-hr. airplane and continuous 80-ft. plywood panels forming the hulls of powerful torpedo boats and striking examples of hundreds of plywood uses made possible by new fabrication methods, adhesives, finishing, design data, etc.

Virtually continuous sheets of plywood are not only possible but might turn out eventually to be the most economical method of manufacture. "Molded plywood" is a material as yet unable to visualize its bounds, with furniture, boats, engine parts, and intricate aircraft parts now being made on a production basis. I-beams are being made of molded plywood, complete in one operation, while plywood tubing of various lengths and of i.d. from ½ in. to 24 in. serve in aircraft, collapsible tent poles, collapsible antenna poles 90 ft. tall and in other military products.

Through the development of new synthetic resin adhesives, structural bonds of wood to plastics and to metal are now possible. Indeed the discovery of the close affinity between some of the synthetic resins and wood substance has led to fundamental changes in the physical properties of wood and have indicated that wood is not merely an inert natural element but a sort of "combined thermoplastic-thermosetting resin with its own filler material in the form of fibers perfectly aligned to produce structurally laminated plastics whose properties exceed those of any similar material so far constructed by man," in the words of Mr. Hess.

Thus in addition to the plywoods, of either the simple laminated or stronger cross-grained varieties, we now have plywoods and solid woods impregnated with resins of various types (including lignin, the wood-substance resin) and in their strongest forms, highly compressed to increase density and raise mechanical properties generally. These denser materials not only are finding wide applications in sheet form, but also are being molded to shape just like compression-molded plastics. Unusually interesting materials and properties are obtained by hydrolizing or otherwise "pulping" the wood structure, then adding a suitable resin and molding to shape.

The characteristics of some of the recently developed engineering woods and some typical properties of familiar natural (untreated) woods are given in the accompanying Tables.

These properties and newly-recognized advantages are leading to ever-increasing uses of wood, often with displacement of other raw materials. Several broad fields in which modern woods in general are finding new applications or strengthening old are worthy of detailed examination.

In Aircraft, Automotive and Consumer Products

Modern woods can save weight and improve durability, two of the chief requirements of aircraft components. Some outstanding examples of successful plywood plane structures are the British Mosquito bomber, the fuselage of the Ryan training plane and Fleetwings' use of molded plywood for some fuselages.

In the case of the Ryan plane the fuselage is molded in two halves with ribs and stringers assembled as part of the molding operation. The bulkheads are of laminated spruce, and the entire skin is made of plywood. On other planes supercharger ducts, nacelle structures, flooring and wing sections are made of modern woods.

Diesel engine cover plates made of wood are strong, much lighter than metal ones, will take oil at any temperature the machinery is likely to throw or splash on it, can be molded into any intricate shapes desired, are excellent thermal and electrical insulators where these qualities are wanted, and are extremely low in cost. They displace steel, cast iron and light weight non-ferrous metals.

Wooden gaskets are used around wind shields, in carburetors and where electrical insulation is wanted. They displace plastics and fabrics. Drip pans for engines are made of wood; the wood will stand the oil and heat. Spacing blocks to keep metal outer shells from touching metal inner shells or beams in refrigerated cars and ships also are made of wood; the wood has high compressive strength for heavy loads, high fatigue resistance to stand operating vibrations, is an excellent insulator and can "take" the extreme dampness and cold on the refrigerated inside of the shell accompanied by the sun heat on the exposed outer shell.

Airplane wings and other parts, automobile and bus bodies, gliders and the like are the single largest users of modern woods. For the oncoming peace time they have shown that curved wooden shapes can be made cheaply and changed cheaply while having high insulating values, rigidity and dimensional stability. No longer need it cost such fantastic sums for dies to change the body lines of a car that only once a year does a car maker dare to attempt this. Where wood will wind up in the oncoming battle with stainless steel, aluminum, plastics and glasses in this market, nobody knows. But the other materials will have to be much better than they were before the war or wood will get the business.

Wood is being tried in bicycle frames, screw type bottle caps, typewriter frames, containers to take the places of tin cans, bath tubs and refrigerator bodies. Wild as these and similar experiments may be, wood has to make good in only a few of them to occupy large volume markets which other materials would like very much to have. Horns for loud speaker systems, X-ray machine parts—the X-rays will go through hydrolized wood panels without making any confusing shadows—one piece radio cabinets with the screw holes to receive the chassis drilled before the wood is molded to shape, are also being developed.

Modern (Specially Processed) Woods and their Characteristics

Types and Designations	Description of Treatment or Product	General Characteristics	Specific Engineering Properties				Typical Uses
			Tensile Strength, p.s.i.	*Rockwell "M" Hardness*	*Specific Gravity*	*Modulus of Elasticity, p.s.i.*	
Plywood; Superpressed Plywood, Laminated Woods, Molded Plywood	Alternate layers of wood veneer and glue or resin; plywoods have veneers in crossed directions	Range of forms and properties, depending on woods, glues, number of plies, thickness of veneers, method of bonding, etc.	5,000-15,000	Varies with veneers used	0.42-0.68	1,000,000-2,300,000	Airplane skins, boat hulls, molded plywood furniture, tubing, masts, buildings
Impregnated Wood; Impreg, Uralloy A and C	Woods impregnated with phenol-formaldehyde, urea, methylolurea, lignin or other resins	Negligible shrinkage or swelling, increased compressive strength, decreased toughness, increased weight	8,000-20,000	—	0.50-1.0	1,000,000-3,000,000	Airplane parts, cabinets, instruments, boats, etc.
Compressed Woods; Densified Woods; Staypak	Solid woods pressed at elevated temperatures to cause lignin to flow	Very tough and strong; some varieties not dimensionally stable	10,000-30,000	—	1.35-1.40	—	Structural applications, packaging, etc.
Impregnated and Compressed; Densified Plywood, Compreg, Presdwood, Pregwood, Panelyte, Tegowood, etc. Many varieties and modifications	Densified product made by resin-impregnation and compression of woods, usually laminated. Moldable	Lightness, high strength, low water-absorption, resistance to swelling and shrinking	10,000-42,000	60-104	1.0-1.45	1,500,000-5,000,000	Airplane propellers, gears and machine parts, electrical equipment, etc., etc.
Hydrolized Woods; Ligno-Cellulose; Masonite; Lignolite	Wood chips are steamed under pressure, exploded into pulp and hot-pressed into sheets and boards, or molded	Range of properties from very hard to very soft. Can be loose and fluffy or hard and solid	7,500-12,000	50-110	about 1.40	about 1,600,000	Machine parts, gears, cams; die stock; building panels, wallboard; foundry pattern plates; insulation
Stabilized; Chemically Treated	Chemical treatments to stabilize dimensions or to protect against fire, drying, fungus, etc.	Wide variety of special properties, as required	—	—	—	—	Outdoor, heat-resistant, low-temperature, corrosive and other applications

Electrical and Construction Uses

Wood is high in dielectric strength and in thermal insulating ability. With the stabilized permanence of dimensions of modern woods and the ease of working them, many electrical uses are being found. Among them are: Panels for cables, circuit breakers, instruments, manual controls, resistance coil switches, switches and terminals, barriers for circuit breakers, bases for bars and switch terminals, brackets for bus bars and circuit breakers, controls, feeder boards, housings for controls, jack bars, inspection and name plates, separators for bus and division bars, coil box spreaders, supports, switch gear cases and pot covers, and washers. These items are markets for dozens of materials which combine structural strength with dielectric strength. But modern wood is likely to hold many of them by its light weight with high strength and its workability, as well as its low cost.

Thin wooden sheets are bent into shapes for fluorescent lighting reflectors, coated with reflecting materials. For some unfathomed reason the wood has an affinity for the reflecting materials and the reflectors (Westinghouse) give off 8% more of reflected light than similarly coated steel ones. And furthermore, the wooden reflectors weigh only one-third to one-fourth as much as steel ones of equal sizes.

Structural lumber is used everywhere. It supports materials handling equipment, power transmission equipment, forms bases for machines, competes with steel and other metals, masonry and mastics as a roof, wall and floor material. For years the trend has been going against lumber because of wood's instability under the severe conditions imposed on industrial buildings. But with modern stabilized woods that trend is being changed.

Builders used to fear the warping effect if water got at wood. Now woods are used in dehumidifyers, culverts, ducts, gutters, down spouts, sinks, stove parts exposed to steam, ice boxes. It is true that paints have been greatly improved and that metal sheathings, asphalt shingles and the like are better protections than ever before. But if these things fail the wood itself can "take it."

An added advantage is that stabilized woods do not present the thermal expansion and contraction problems of untreated lumber. One of the classic metal roof problems has been that copper expands under heat while its wooden support contracts. But the stabilized wood will respond very little to the increased or decreased temperature and therefore the only thermal movement problem on the roof will be that of the copper itself.

Structural trusses, arches and the like often are made of many small pieces of wood—perhaps inch square stock—glued together to make up any thickness desired. This is not a slow hand operation but is done in special machines. The glue being stronger than the wood, the strength is that of the wood. By varying the kinds, thicknesses, qualities and grain directions of the wooden pieces, the finished article can be varied in thickness, strength, resiliency, curvature and shape along its length. If heavy, say 8 by 8 in. or 24 by 24 in., it invariably is stronger than any solid piece of wood of the same kind and size could be. The knots, shakes and blemishes have been removed.

Steel connecting rings and other metal connectors greatly increase the strengths of structures in which heavy or light wooden beams must be joined. They decrease the thickness and weight of the wood needed and therefore reduce the cost.

Wooden pipes are a centuries old story. With improved production methods and better woods they are finding additional uses, especially in chemical plants and other places handling liquids that will attack iron but not wood. Wooden pipes compete with glass, plastics, rubber, ceramics and special metals.

For Tools, Dies and Fixtures

Some modern woods, especially those which have been compressed to about one-fifth of their original thicknesses and some of those made of hydrolized woods and then heavily compressed, are so hard that they must be cut and ground to shape on metal working equipment. These woods generally cut and work about like bronze. Kerosene is used as a coolant when grinding.

Wood blocks with restrained rubber pads are used on simple hydraulic and toggle presses for forming and shearing thin sheet metal; they displace far more costly steel mating dies. Other wood blocks back up springy metal or plastics parts to add stiffness. Still others are used for extruding and for wiping.

One master mechanic calculates that his wood die stock has one-sixth the weight of steel, and every bit of weight in a moving machine part means just that much more power which must be paid for and force which must be controlled. His further calculations are that the wood raw material cost is one-fourth that of steel and the tool maker's time to produce a die is one-tenth. In another shop, pressed wood dies took four days of tool-making time to produce while steel dies for the same job needed eight days.

There are examples of wood supplementing tool steel. Thus large parts may be partially deep drawn with steel dies and then spun or stretched to shape on wooden forms or chucks.

A partial list of the kinds of dies now made of wood will indicate how far this technique has gone. It includes blanking, brake, deep draw pressure ring, deforming, forming, hydraulic expanding ring, mating, press brake, shear and stretcher. To this may be added die bases to which steel facings are glued and screwed; these may be far less costly than the all steel kinds.

Propeller blocks (Pregwood) are shown being loaded into the veneer press after having been glued simultaneously with phenolic resin. (Courtesy: Formica Insulation Co.)

Like wooden dies, wooden fixtures are great time savers when making changeovers from one war product to another or to peace lines. A partial list of those in use is: Assembly, centering, checking, drill, inspecting, riveting, spot welding, trimming and welding. There are many wooden fixture pads also. Resistance to warping when exposed to soluble cutting oil, stability under wide changes in working temperatures and abilities to stand rough treatment when handling and clamping, are needed by the woods in these fixtures. Mild steel and cast iron are the metals most frequently displaced.

Jigs are made of wood in increasing numbers. A few of the kinds are: Assembly, cradle, drill and table.

With cheaper router and pantograph forms, routing becomes more of a competitor of punch press work for the trimming of stampings which have complex edge forms, irregular shaped cutouts or holes extremely close together. And this is just one of the cases in which the availability of low cost wooden tools to displace higher cost steel ones is causing one machine operation to displace another. Wooden cam forms are reducing the costs of automatic control mechanisms; they displace steel. Other wooden forms are: Bending, corrugating, saddle type and stretching.

One company uses inexpensive wooden molds for plastics if production is not to run over 300 to 400 parts; higher cost steel molds are used for anything over that. Wooden backing-up plates permit high-accuracy, high-finish milling of plastic laminates and other springy materials—a final polishing operation is eliminated.

Wooden templates for checking, master, nibbling, outline, pantograph, photo, router and strippet punch have displaced aluminum and other light material templates. Nibbling or otherwise accidentally damaging the edge of a wooden template involves little cost for time and materials to replace it. Spare wooden templates can be made when cutting out the originals on the contour band saw. Modern wooden ones

Here is a tubular plywood mast for a directive radio antenna, one of many now in use. The masts are telescopic and come in various standard lengths, with sections less than 12 ft. long. (Courtesy: Plymold Corp.)

Properties of Natural Woods Parallel to Grain (Based on 15 per cent moisture content)

Species	*Specific Gravity, Average*	*Fiber stress, at elastic limit, p.s.i.*	*Modulus of elasticity, p.s.i.*
Ash, commercial white	0.62	8,900	1,460,000
Birch	0.68	9,500	1,780,000
Hickory	0.79	10,600	1,860,000
Maple, hard	0.67	9,500	1,600,000
Oak, white and red	0.69	7,800	1,490,000
Cypress, southern	0.48	7,100	1,270,000
Douglas fir	0.51	8,000	1,700,000
Pine, Norway	0.51	8,500	1,560,000
Spruce	0.40	6,200	1,300,000

can be stored without fear of warpage or creep or other dimensional changes.

Straight edges and surface plates for machine shop use are made of wood. The modern treated woods are hard enough, true working enough and durable enough to permit this. Temporary fastenings of wood to hold work for welding, riveting, soldering or gluing, are light enough so women handle them easily, and are non-marring and durable. Trimming fixtures for Plexiglas, tool handles, tool boxes, table tops which will not be marred by sharp tools and are not prone to dull the tools, performing dies for laminated plastics when no spring back is permissible, tumbling barrel linings which may be replaced at will to change the shapes of the barrel insides and therefore the cascading motions imparted to the tumbled parts—all are made of wood. And in many cases the wood is displacing cast iron, steel and other metals.

As Machinery Parts

Wooden pump bodies and plungers are being used, especially for some chemicals. They displace glass, ceramics, some metals. Wooden hubs for gears are easy to understand when weight saving is an objective and the gears are large in diameter. But modern woods have enough resistance to shear so that entire gears and ratchets are made from them. These parts, like wooden bushings for use as bearings, can be impregnated with lubricants after which they will run for years without further lubrication.

Wooden brake blocks and idler blocks are a centuries-old story; the modern ones are great improvements and are regaining for wood some of the applications it had lost to asbestos and other friction materials.

Spindles need stiffness to avoid whipping or other deflecting while revolving at high speeds. Light weight is desirable also. Modern woods have these qualities and are displacing steels. Flat springs were made of wood before steel became suitable. Modern woods are of higher resiliencies, the resiliency of one wooden strip can be more closely duplicated in another than Dame Nature ever was able to do, and the resiliencies are maintained over longer working lives. Therefore wooden springs are being made.

Machine guards from formed wooden strips are lighter and more rigid than the steel ones they displace. Cutting wheel backs, permitting the stiffness to be supplied by inexpensive woods while the cutting edges are of thin steels, are low in cost but high in effectiveness.

Wooden hinges, bolts and nuts, and flash light shells are typical of a long list of parts that now are made only as "stunts" but later may find permanent uses.

Wood long has been a preferred material for stringers and other supports for overhead shafting. The maintenance man could fasten it wherever he liked, and could bolt his hangers to it anywhere it ran. The trouble was the wood would check, crack, warp, shrink, swell, loosen, or rattle. Modern woods do not give these troubles. They are coming back to displace steel shapes.

Wooden pulleys for flat belts are an old story. They are light in weight and have high coefficients of friction, therefore they can transmit more power per inch of belt width while absorbing less of it themselves. Their old troubles were inability to absorb extremely heavy shock loads, and likelihood to warp and even break apart in damp or wet surroundings. Modern woods have neither of these shortcomings. Wooden pulleys made of them compete with cast iron, pressed steel, paper and plastics. Wooden hubs for steel or iron pulleys are weight savers.

V-belt sheaves are made of modern woods. When V-belt drives were new it was thought that the high coefficient of friction of wood and the light weight (cutting down on sheave inertia when shock or fluctuating loads demand quick changes of speeds) never would be available to them. But wooden sheaves can be completely true running while extremely light in weight, and therefore are displacing iron and steel ones.

Other power transmission uses are: Rope sheaves, belt guards, chain and gear casings (modern woods can stand oil even at 190 F), chain guides, bearings and ratchet brakes.

Fabricators of laminated plastics products prefer modern wooden dies; the metal conducts heat too easily from the pieces being formed and prevents them from setting properly. Likewise the fabricators of some thermosetting plastics in which the punch must dwell while the material sets, find that metal dies remove too much heat while the less costly wooden ones do not.

Furnaces and other heat exuding equipment often are placed in or near production lines. They must be walled off for the sake of nearby workers and machines. Modern woods make excellent insulating walls, especially if faced with heat reflecting paints. Such walls are space-saving, thin, light in weight, and are readily convertible to other uses.

In foundries modern woods are fighting back at the aluminum alloys and other light weight metals which had so often displaced wood for match plate use. These woods do not warp, shrink nor change dimensions in the hot, dry air. Wood also is used in shaker boxes, flask filler boxes, molding machine straightening blocks, and the like.

In Materials-Handling Equipment

The original gravity conveyor rollers, more than 30 years ago, were wooden with steel shafts. Later the splintering wood was almost entirely displaced by steel tubing with steel shafts. Now the processed woods are coming back; they are light, non-splintering, resilient, less damaged by water or chemicals. Steel shafts remain. No one knows which material will have the longest average service life but in some installations Compreg (St. Regis Paper Co.) rollers are outlasting steel for hard duty.

Modern woods are displacing cast iron as cable guides; the wood loads up with lubricant, is long-lived and non-abrasive. As idler and guide pulleys beneath troughed belts woods have belt saving light weights and are water resistant and long-lived.

Coefficient of friction is a problem in materials handling; if it cannot be varied, then devices must be limited as to working angles and pressures or made to specific sizes to cope with it. But coefficient of friction can be varied at will within wide limits in modern woods, therefore these woods are displacing steel and other materials for head pulleys, slider boards, chutes, spill boards and buckets.

Other materials handling uses of woods include loading pallets, bulk heads, dipping box separators, wear plates, bins, shelves, silos, tanks, and tank relinings. Truck bodies can be built up by gluing together small pieces of wood so the bodies are shaped to the contours of the materials to be carried, are thick where thickness is needed and thinner at other parts, and are unusually light in weight for their high durabilities. Truck caster wheels are made of light but durable modern woods that have no grains to split. Wood is used in pans into which hot ashes fall.

Modern woods are excellent non-sparking materials. Therefore where explosions are a hazard, wood with no metal at friction or abrading surfaces is used in wheels, scoops, shovels, bins, buckets, barrels and separators. Here the wood displaces highly expensive non-sparking non-ferrous metal parts.

Miscellaneous Uses

Modern woods are found in all sorts of industrial equipment. Examples:

Liners for infra-red kilns. The woods are good insulators, excellent bases for reflective coatings. They displace ceramics and asbestos backed steel.

Liners for dyeing and other chemicals processing tumbling barrels. Sometimes whole barrels are made of modern woods. They compete with Monel metal, stainless steel, and glass.

In chemicals plants: Bins and hoppers, fermenters, filter presses, heat exchangers, scrubbers, shipping containers, tanks, conveyors, piping.

Spray masks for painting propeller hubs and other intricate shaped parts; the wooden sheets are easy to form, inexpensive, light weight for quick and tireless handling.

Cutting boards in foods plants and kitchens. The woods will not mar nor scratch nor splinter under the knives and will dull knives less than would harder materials.

Keller profiler patterns in tool rooms. Shoe lasts for shoemakers. Mock ups, stock racks, stack racks, experimental models.

As mentioned earlier, nobody knows just how wood will fare in the oncoming peacetime battle of the materials—steels, aluminum alloys, copper, glass, ceramics, plastics, etc. But right now wood seems to be creating as many markets as it takes away. Wooden dies displace some tool steel, permit the use of more intricately shaped parts which will need more tool steel, and create brand new markets for sheet steel. Wooden molds decrease the costs of fabricating the very plastics parts which will compete with wooden items for the same markets. Wooden structural members increase the practicabilities of copper, steel, concrete and other materials, and, by decreasing the overall costs of building while increasing the varieties and features that buildings may have, the woods may sell more of those other materials than they displace.

Another sign that the use of woods will increase, is that most of the processes which turn untreated woods into modern woods are chemical in nature, and the world is at the beginning of the "chemical age."

A Methods Article A brand new development of considerable importance to the future use of magnesium sheet is the successful technique of hot deep-drawing magnesium propeller domes from heavy-gage stock described in this article. Design and production aspects are broadly covered.

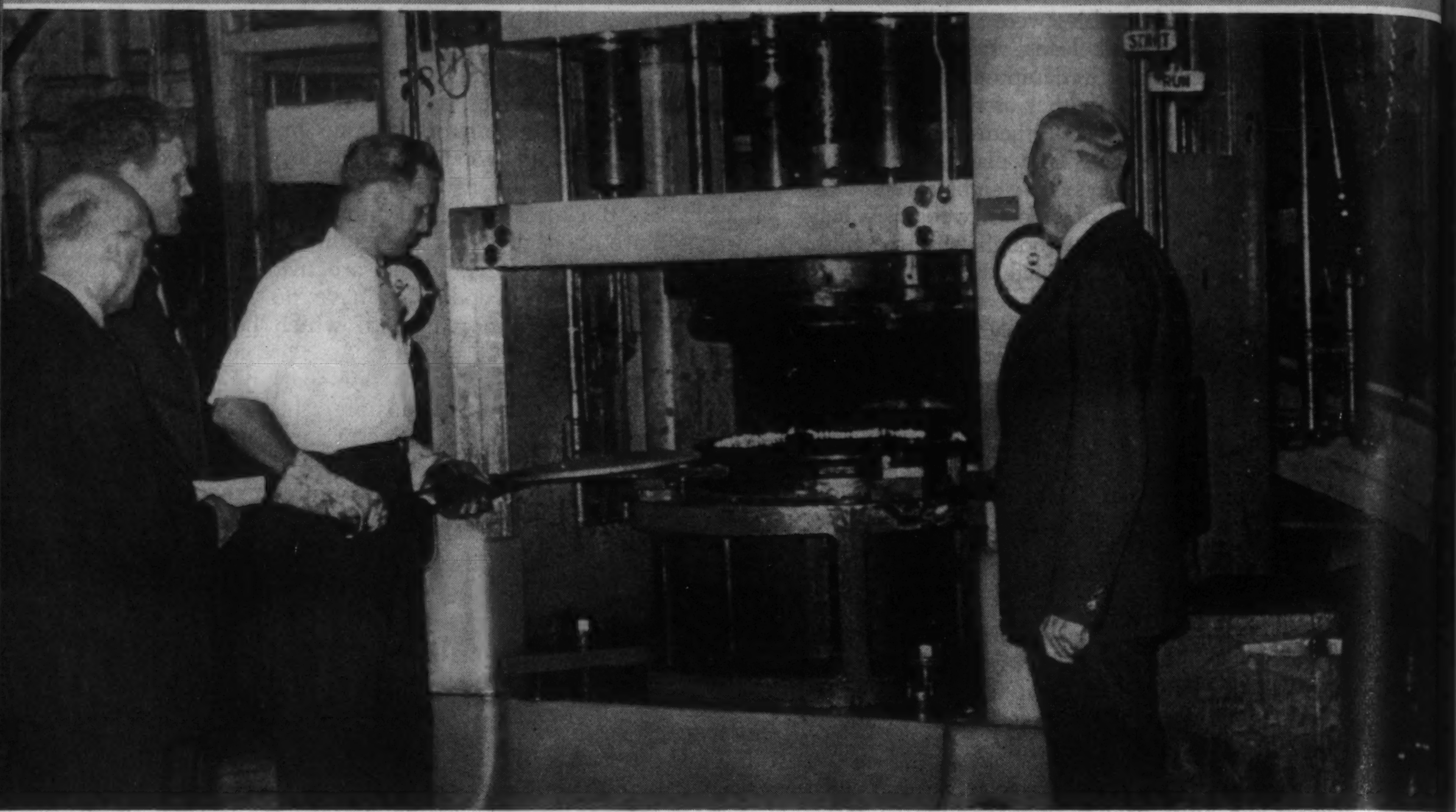


Fig. 1. Hot deep drawing of heavy magnesium plate.

Deep Drawing Magnesium Domes

by J. WALTER GULLIKSEN

Mechanical Engineer, Worcester Pressed Steel Co., Worcester, Mass.

THE TECHNIQUE of press working magnesium has made rapid strides in the last few years and recent developments at the Worcester Pressed Steel Co. mark another advance in the application of deep drawing and ironing operations to this remarkable metal.

The average stamping manufacturer who has become familiar with draw press work on metals such as copper, aluminum and low carbon steel, would certainly get a very poor first impression of the workability of magnesium from the usual methods of judging this quality. If he merely bent a piece of light gage sheet back and forth in his hands it would quickly break at the bend, giving mute evidence to its brittleness. Yet those companies with sufficient pioneering spirit to tackle the press working of this metal have found it very plastic and formable, when once the secret of handling it has been mastered.

Metallurgically, the explanation of this paradox lies in the fact that the crystallographic form of magnesium is "hexagonal close-packed." This space lattice arrangement is much less conducive to plasticity at room temperature than the face centered cubic lattice of aluminum or copper and the body centered cubic structure of iron.

The wrought magnesium alloys work harden rapidly when formed at room temperature. This greatly limits cold working possibilities. At temperatures of approximately 300 F there is a marked increase in workability. This property continues to improve as the temperature is further increased and reaches a maximum at about 600 to 650 F.

In language familiar to the stamping and drawing craftsman, 20% reduction in diameter would be about the maximum possible in a double action cupping operation at room temperature. At 600 F it is possible to achieve reductions of 50 to 60%.

Most of the deep drawing and forming work which has been developed for the wrought magnesium alloys has been concerned with light and medium gage sheet; i.e., 0.125-in. gage and under. The majority of such parts have been such as to require only one or two press operations.

Design, Material and Processing

In order to explore the field of deep drawing magnesium still further, the Worcester Pressed Steel Co. selected a part which would involve a whole series of press operations and include "ironing" of the side wall, indenting and "upsetting" as well as a "double action" draw press operation. A sequence of this type is required in the fabrication of the propeller dome which houses the feathering mechanism of the Hamilton standard propeller. These domes have been in quantity production in aluminum at this plant since 1939, having been developed there from a forging into a deep drawn stamping.

Fig. 2 shows the significant dimensions of this dome. It can readily be seen that this part combines many difficult features. The overall dimensions and the heavy gage alone place this job in the unusual class. Add to this, the ironing of the side wall to give the varying wall thickness, the severe forming of the depressed section in the head and the upsetting operation required to thicken up the flange and the result is a job which presents a real challenge to the craftsman. Consultation with the leading magnesium manufacturers revealed that, to their knowledge, magnesium of the heavy gage involved had not been deep drawn to such an extent and that "ironing" operations of the type required had not been attempted.

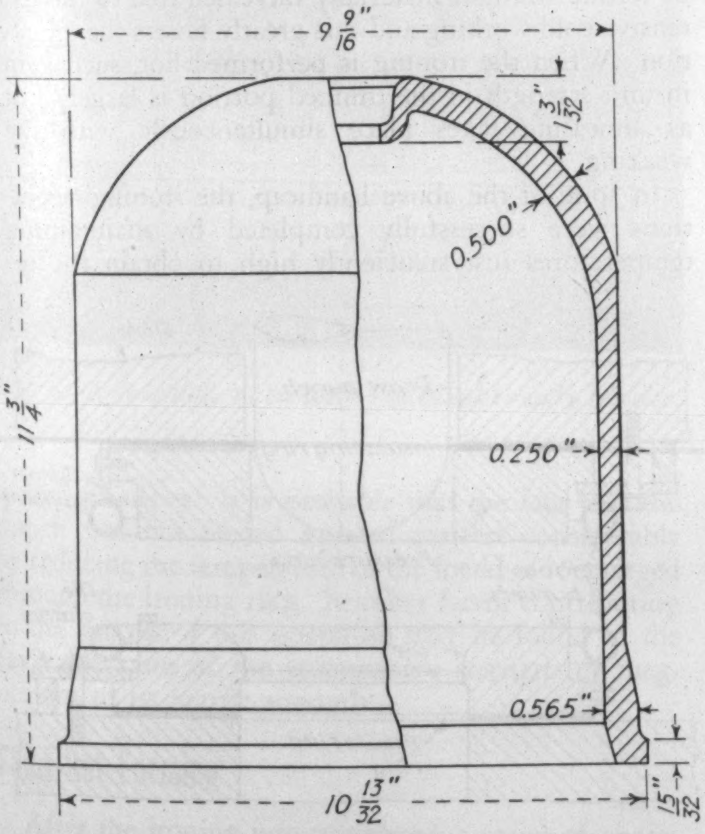


Fig. 2. Essential dimensions of completed magnesium propeller dome.

In view of these facts, the fabrication of a magnesium dome from plate by means of draw press operations was a development well calculated to test the formability of the metal to the utmost. The results amply justified the claims of the champions of this "newcomer" among the metals.

Fig. 3 illustrates the magnesium domes in various stages of completion. On the extreme left is a cup after the "double action" drawing operation. Next in line is a cup after the first "ironing" operation and then a cup after the final "ironing" operation. The increase in length due to reducing the wall gage is very marked. The 12-in. draftsman's scale gives an approximate idea of the relative sizes. On the extreme right is a completed dome. Note the formed depression in the spherical end and the "upset" flange at the open end.

A wrought magnesium alloy of the following composition was selected as being best suited for this work:

	Per Cent
Aluminum	3.00
Zinc	1.00
Manganese	0.20
Magnesium	95.80

This alloy is designated AM-C52S by the American Magnesium Corp. and Dowmetal FS-1 by the Dow Chemical Co. Its principal physical properties in the annealed condition are about as follows:

Yield strength, p.s.i.	21,000
Ultimate tensile strength, p.s.i.	38,000
Elongation (in 2 in.), %	18
Brinell hardness	54

The blanks used were discs 19¼ in. in diameter, cut from plate 0.500 in. (plus 0.040 in. minus 0.000 in.) gage. The "double action" draw tools for the first operation were designed to form these blanks into cups 9.150 in. inside diameter by approximately 10¼ in. long. This constitutes a reduction in diameter of 52.5%.

In the production of the standard 61ST aluminum dome, two steps are required to achieve this result. The aluminum cup first drawn from the 19¼-in. diam. disc, is $10^{15}/_{16}$ in. i.d., a reduction of 43%. The second draw constitutes a further reduction of 16% to produce the 9.150 in. i.d. cup. Thus we find one "hot drawing" operation on magnesium replacing two "cold drawing" operations on the equivalent aluminum part.

The Hot Drawing Operation

Fig. 1 depicts the hot drawing operation being performed in a 300-ton hydraulic double action press. The preheated blanks are inserted by means of tongs. Fig. 4 is a "close up" view of the drawing tools and

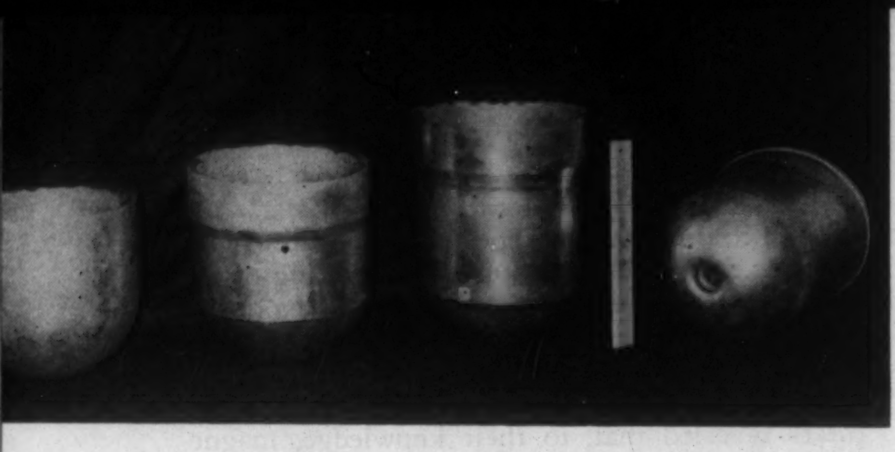


Fig. 3. Magnesium propeller domes in various stages of production.

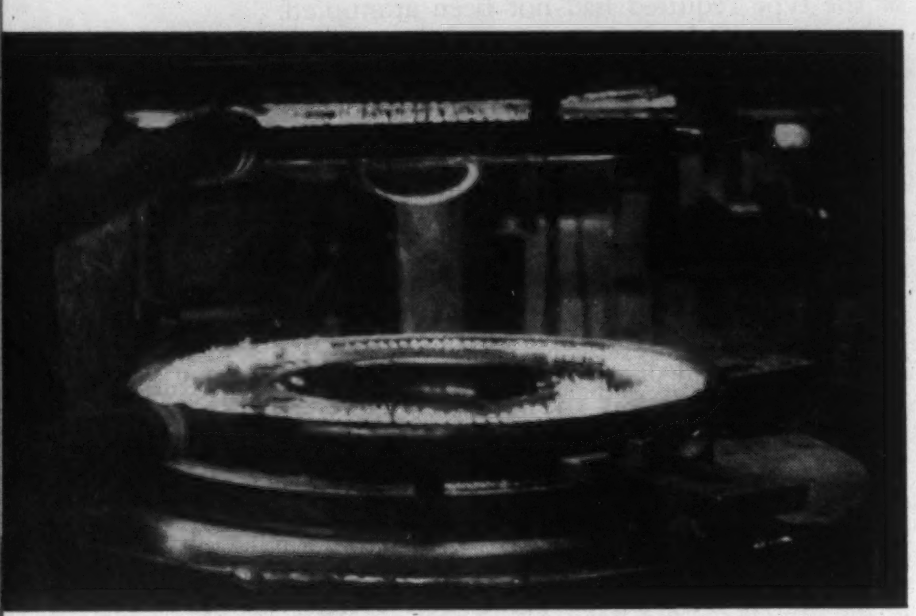


Fig. 4. Double action draw tools heated by gas ring burners.

the ring burners used to obtain the proper temperature. Approximately 2 hr. were required to heat the tools before starting production.

The essential features of the draw tools and heating arrangement are shown diagrammatically in Fig. 5. The die and pressure ring were heated but not the punch. It is not desirable to heat the male member of the tools, since the deformation is complete when the blank conforms to the shape of the punch. It is then best to allow the temperature of the magnesium to drop by contact with the cool punch, increasing its tensile strength somewhat and thus reducing the likelihood of rupture as the remaining metal is pulled through the die.

Gas ring burners were used to heat the die and the pressure ring. A flexible coupling between the gas mixer and the burner surrounding the pressure ring permitted the normal movement of this member during the press operation. Transite insulator rings were placed as shown to reduce heat losses.

Light gage magnesium parts may sometimes be drawn without pre-heating the blanks, depending on heat transfer from contact with the tools to produce the required plasticity. In the case of the heavy stock required for these domes, this procedure would be impractical and therefore the discs were pre-heated in an electric furnace to approximately 600 F. Fig. 6 shows the discs in the vestibule of an insulated chamber where they were kept hot ready for use. A contact pyrometer was used to check the temperature of the tools and the blanks.

In the course of the "double action" cupping operation there was ample evidence of the importance of maintaining the proper operating temperature. In order to obtain some experimental data, the temperature was allowed to drop. The effect was immediately obvious. At 450 F lateral breaks about ½ in. long appeared in the side wall. When the temperature dropped to about 375 F the punch broke through the domed end, splitting it apart without drawing the blank through the die. On all subsequent operations temperatures of 500 to 600 F were maintained.

The "Ironing" Process

After the "double action" operation, the cups were as shown in Fig. 7. As usual after such operations, the thickness of the wall was approximately uniform and equal to the thickness of the original blank. The next operations were concerned with reducing or "ironing" the sidewall. As shown in Fig. 2, the sidewall must be 0.250 in. thick, increasing to 0.565 in. thick, and then stepped out to a flange $10^{13}/_{32}$ in. o.d. by $^{15}/_{32}$ in. wide at the open end.

The first ironing operation consists of reducing the side wall to 0.333 in. gage for a length of 4½ in. This amounts to a reduction in thickness of 37%. There was considerable skepticism regarding the ability of magnesium to stand this type of operation. An analysis of the stresses involved reveals that hot working introduces a complication not met with in similar cold ironing operations.

Fig. 8 shows the essential elements of the ironing tools and Fig. 9 gives the significant dimensions of the part after the operation. Note that the punch must pull the metal through the "ironing" ring. As the operation proceeds, the sidewall of the part is in tension. The force required to pull the remainder of the dome through the ring is distributed over an annular section which has been reduced to 0.333 in. in thickness.

In the case of cold drawn metal, that portion of the sidewall which has passed through the ring has had its tensile strength materially increased due to the extensive cold working and this greatly favors the operation. When the ironing is performed hot, such gain in unit strength in the thinned portion is largely lost as annealing takes place simultaneously with the working.

In spite of the above handicap, the ironing operations were successfully completed by maintaining temperatures just sufficiently high to obtain the re-

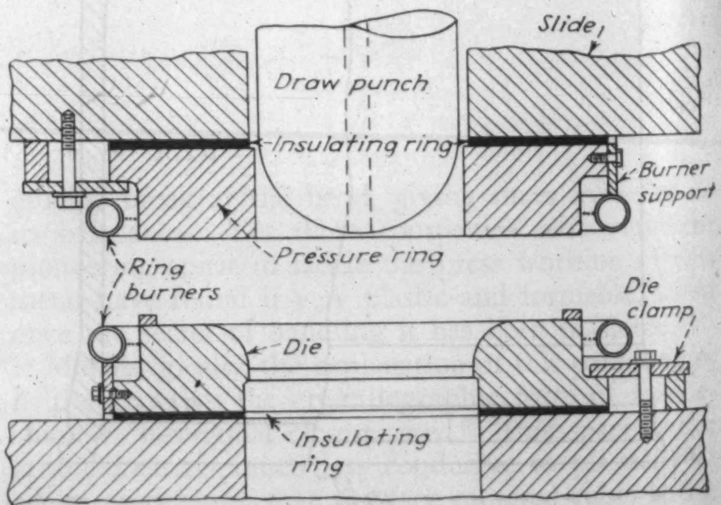


Fig. 5. Double action drawing tools with heating arrangement.

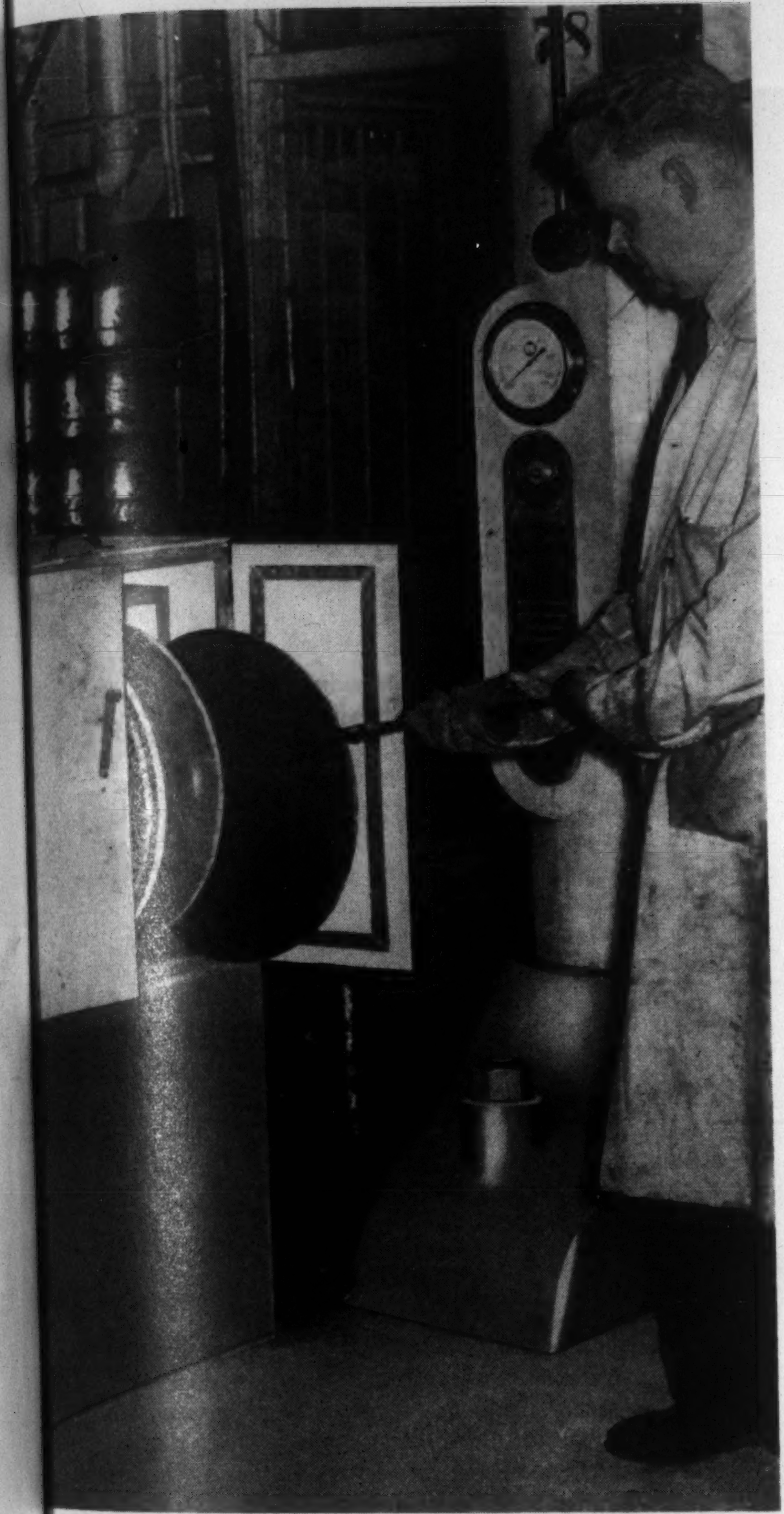


Fig. 6. *A vestibule oven with hot blanks ready for use.*

quired plasticity. It is probable that the fact that the punch was not heated assisted matters considerably by reducing the temperature of the metal as it emerged through the ironing ring. Another factor contributing to the success of this operation may be found in the favorable ratio of the compressive strength of magnesium to its tensile strength.

Final Hot Forming

After the ironing was completed, a series of operations were required to form the indentation in the spherical end. This depression presented difficulties due to its depth and the sharpness of the corner radii.

A ⅝-in. diameter hole was pierced in the center of the dome. In order to avoid shear cracks which might open further in the subsequent forming, the piercing operation was also performed hot. This gave a relatively clean cut surface in the hole.

The first hot forming operation was made with large radii to facilitate drawing or gathering sufficient metal in the depressed portion. Subsequent hot forming operations increased the depth and sharpened the contour of the indentation. A certain amount of stretching and coining was inherent in these operations and in some ways this phase of the job was the severest. Magnesium again demonstrated its ability to take considerable punishment.

The open end was next machined off square to a length slightly longer than the desired finished length, providing sufficient stock for the final upsetting of the flange at the open end. The final hot press operation consisted of striking the entire dome in a closed die, upsetting the flange and "sizing" all dimensions.

Lubrication and Cleaning

Lubrication in the hot deep drawing of magnesium is a problem which invites further research on the part of manufacturers. Ordinary drawing lubricants are not adequate at the high temperatures involved. Graphite is an excellent lubricant but introduces a troublesome cleaning problem. The successful use of yellow laundry soap has been reported on some drawn magnesium parts but in operations as severe as those described in this article, a superior lubricant is essential.

Good results were obtained by spraying the blanks with colloidal graphite suspended in mineral spirits. Acheson dispersion No. 2404 worked well. A mixture of colloidal graphite and Houghton's "Cyltal" also gave fairly good results when applied to tools and parts with a swab. These graphite lubricants left a difficult cleaning job in their wake. No intermediate cleaning operations were used and the repeated heating and working of the metal served to imbed the graphite in the surface of the parts.

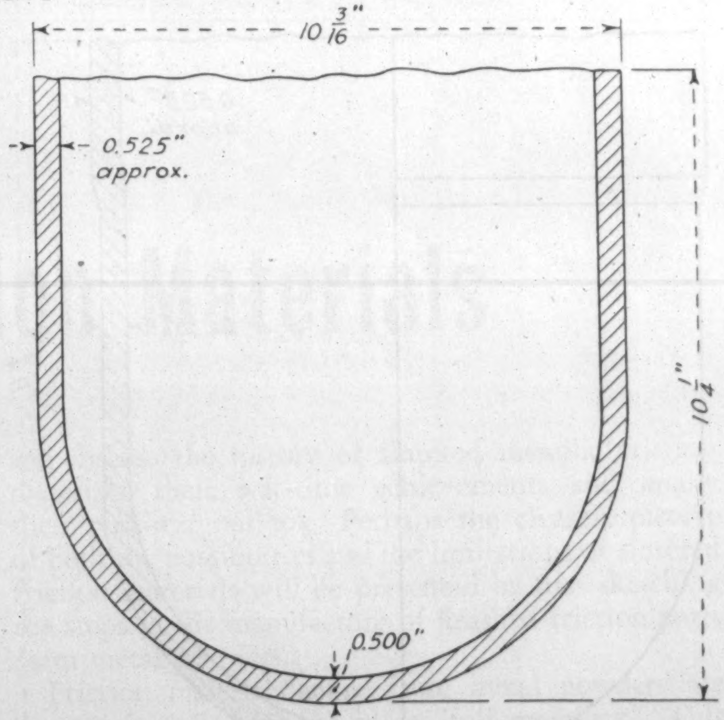


Fig. 7. *A magnesium cup after the first draw.*

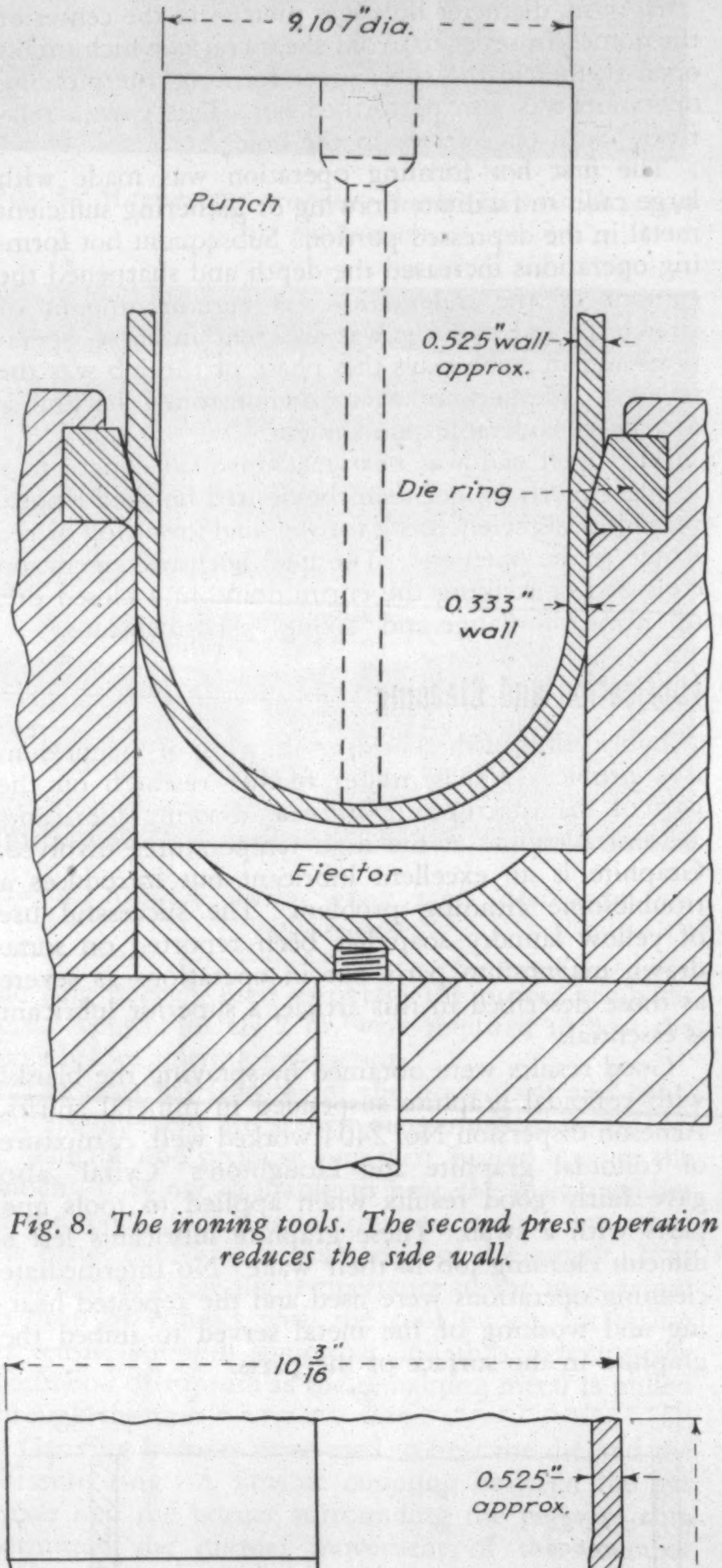


Fig. 8. The ironing tools. The second press operation reduces the side wall.

Several methods of cleaning were tried out. Scrubbing in a citric acid bath (1 lb. citric acid powder per gallon of water) removed the graphite and left a bright silvery surface. The acid loosened the graphite by attacking the base metal and fairly brisk rubbing was necessary to clean the parts before excessive localized etching took place. A cleaning bath of 15% chromic acid near the boiling point was also found efficacious but this is disagreeable to use and the fumes are harmful to the nasal tissues.

The best cleaning results were obtained by means of a chromic acid and calcium nitrate solution. Four ounces of calcium nitrate were used per gallon of 15% chromic acid and immersion of the parts in this bath for approximately 5 min. at room temperature proved quite effective. After this cleaning, the domes were ready for any of the standard surface treatments for inhibiting corrosion.

General Observations

One of the complications introduced by "hot drawing" which was not encountered in "cold drawing" was shrinkage when the parts cooled down to room temperature. This element must be taken into account by calculations at the time the tools are made.

It must be kept in mind that the tools expand when heated and this action opposes the shrinkage of the parts when cooling. However, the thermal coefficient of expansion of magnesium is over twice that of steel and the net thermal effect is considerable. The actual net shrinkage on the domes amounted to approximately 0.030 in. on the outside diameter and to proportional amounts on other dimensions.

The slight additional complication involved in allowing for shrinkage is more than offset by the fact that in hot drawing "springback" is almost entirely eliminated. This is a considerable advantage as the amount of "springback" in cold drawing operations can not always be predetermined accurately. Furthermore, variations in the raw material may produce varying amounts of "springback" in the drawn parts. In the design of tools for hot drawing magnesium, this rather troublesome factor may be ignored.

An interesting check on the physical properties of the drawn magnesium dome was made on four physical test specimens cut from various portions of the side wall. The average results follow:

Yield strength, p.s.i.	19,000
Ultimate tensile strength, p.s.i.	38,000
Elongation (in 2 in.), %	19
Brinell hardness	57

These properties indicate that the material, after the extensive hot forming, corresponded closely to the original plate in the annealed condition.

It is felt that this development of production technique for fabricating these magnesium domes from ½-in. plate by hot press operations involving deep drawing, ironing, piercing, indenting, upsetting and sizing is a definite contribution to the art of fabricating the metal. The results obtained furnish testimony to the plasticity and formability of magnesium when the proper methods are used.

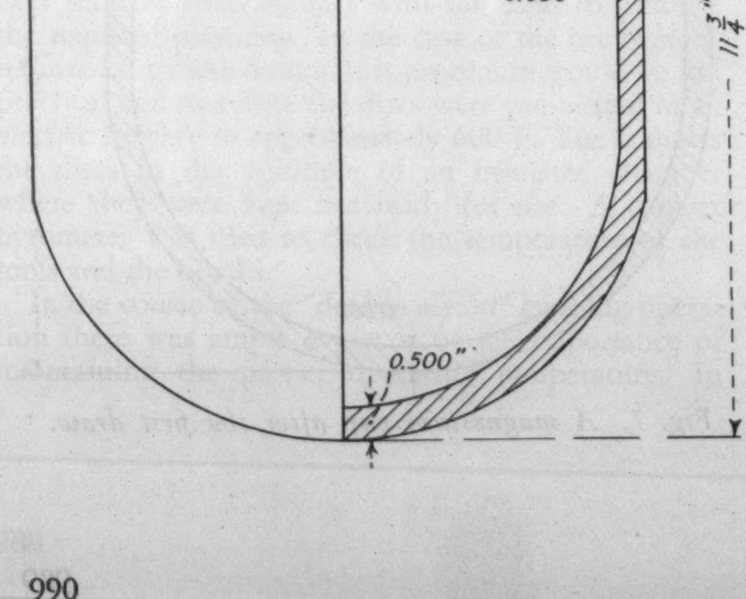
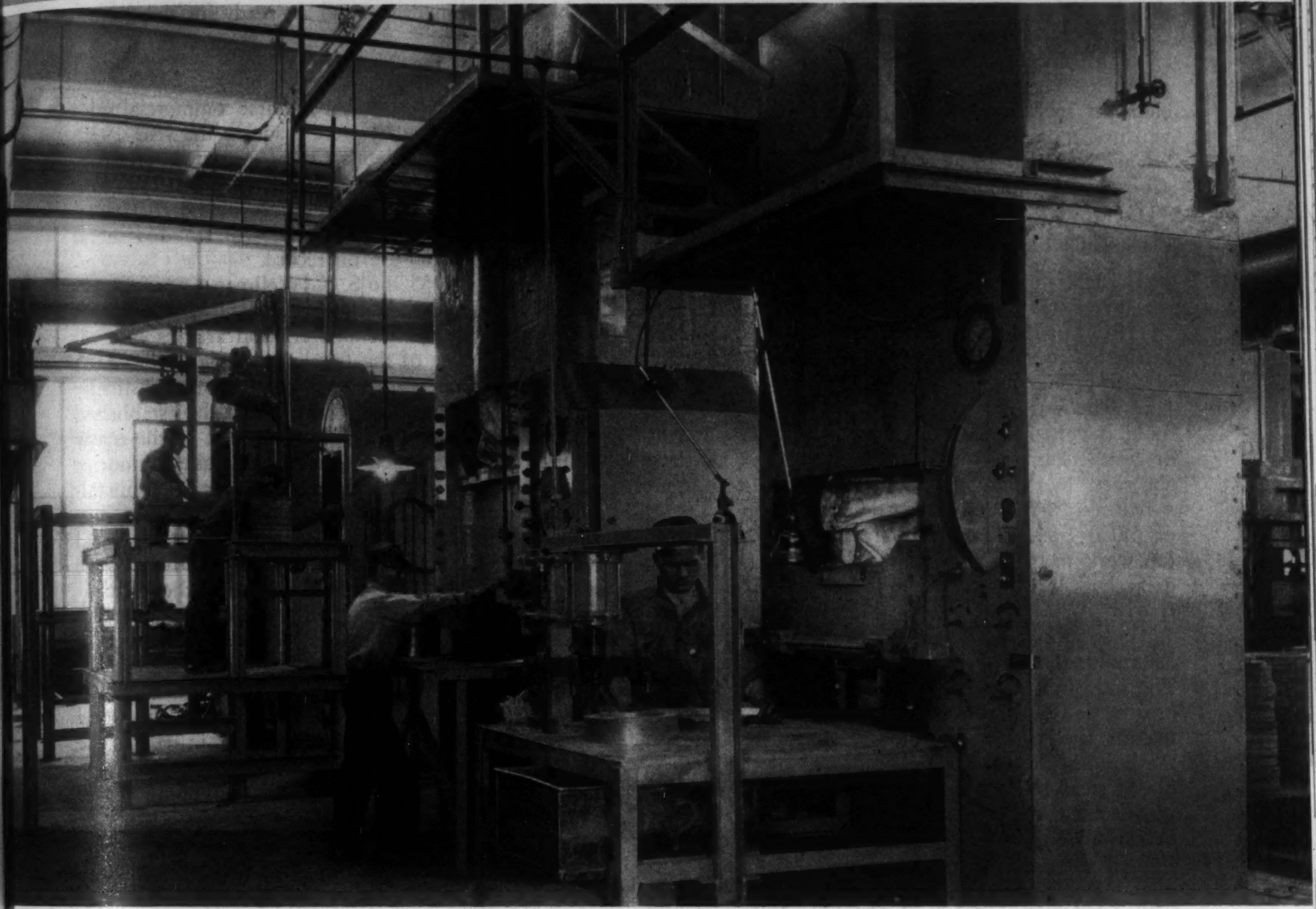


Fig. 9. The magnesium cup after ironing.

A Materials Article Sintered metallic friction materials in forms and sizes once considered impossible are today serving ruggedly in brake linings, clutch rings and faces, automatic transmission plates, etc., for aircraft, tanks, trucks, and other equipment. In this article (originally presented as a paper at the Cleveland meeting of the Metal Powder Association) Mr. Batchellor outlines the characteristics, present uses and future prospects of these important powder metallurgy products.



Line of presses producing heavy-duty clutch facings from metal powders.

Metal-Powder Friction Materials

by CLYDE S. BATCHELOR

Corporation Metallurgist,
The Raybestos Division of Raybestos-Manhattan, Inc.
Bridgeport, Conn.

IN ORDER TO SHOW how metal powders are used in this comparatively new phase of the powder metal industry, this article will describe briefly the method of fabricating sintered metallic friction articles and discuss the history of sintered metallic friction materials, their war-time achievements and finally their post-war outlook. Perhaps the clearest picture of both the possibilities and the limitations of sintered friction materials will be presented by first sketching the steps in the manufacture of finished friction parts from metal powders.

Friction materials made from metal powders are commonly called by the trade "full metallics." This term is misleading, since there are substantial percentages of non-metallic material present. The metal powder mixes used to make the friction compact commonly comprise copper, tin, lead, and iron, all of 150 mesh or finer. Graphite is present in varying percentages as a lubricant. Other non-metallic elements such as alundum, silica, and carborundum, which are known as "friction-augmenting agents," are added, and in some cases ceramic materials which act as a part of the bond and affect frictional qualities.

Processing the Materials

The first step in processing is that of weighing the metal powders and other ingredients and mixing them in a Read or Ray mixer. The powder is then molded to the desired shapes in hardened steel molds in hydraulic presses, at pressures on the order of 20,000 p.s.i. The wafer or "cookie" which comes from the mold is very fragile. However, during the sintering or heat treatment the tin will be at least partially absorbed by the copper, and the bronze compact which results will have a tensile strength on the order of 5,000 p.s.i. This material is usually considered too weak to be used without reinforcement, and the great bulk of sintered friction material is sold sintered onto a copper-plated steel core or backing.

To accomplish this sintering operation the work is arranged in a vertical stack on the furnace base. The industry has apparently standardized on the use of the bell-type furnace with an inner retort. In making the stack a graphited steel spacer is laid on the bottom, then a "cookie," followed by the copper-plated steel backing plate. With another graphited spacer the cycle is started again. The work is piled in this manner to the desired height and carefully aligned vertically by means of fixtures for this purpose. In the case of a steel disc which is to be faced with friction material on both sides, it is arranged that a wafer is in contact with each side of the copper-plated steel, in building up the stack.

The alloy inner retort is then placed over the "charge" and the "bell" or furnace is lowered onto the base. Pressure is applied on the stack during heating through the roof of the furnace by an air jack or other suitable means.

It is not possible to go into much detail about the furnace loading and operation, since it is a variable and somewhat complex operation. It may be generally stated that the heating necessary is ½ hr. after the furnace load reaches the sintering temperature, which ranges from 1300 to 1550 F but most commonly is on the order of 1350 F. However, the heating cycle varies with the amount and nature of the "charge." The cooling cycle also depends upon the size and nature of the charge, and may vary from 4 to 20 hr. Generally articles which have precise dimensions, with little stock allowed for further finishing, require long cooling periods, while more massive articles may be cooled more rapidly.

In present practice the furnace atmosphere is controlled by addition of charcoal or coke to the inner retort. This is not a particularly good arrangement, since there is apparently no appreciable protection from oxidation of the powder metal compact on the rising heat, before sintering occurs. After removal from the furnace the friction articles are machined to blueprint dimensions and are ready for shipment.

Background of the Product

It is generally agreed that the first commercial sales of appreciable quantity were made in the year 1932, when the General Metals Co. of Akron entered the new field. There had been considerable research work of a more-or-less spasmodic nature before that time, and several earlier individual sales of sintered metal as friction material are on record.

In the year 1935 the S. K. Wellman Co. of Cleveland also entered the field, and these two companies introduced sintered metallic friction articles into almost every phase of the friction material trade. Like most new products, this one was overenthusiastically regarded by some. On the other hand the established friction material industry chose to look at the many failures of sintered metal and failed to take due notice of the successful installations. However, early installations in the farm equipment and earth-moving machinery fields had been immediately successful, and within a few years substantial inroads had been made in the asbestos friction material sales to these industries by the new product. This product had unquestioned "sales appeal," but the cost of its manufacture and, therefore, its selling price were keeping it out of many more applications.

The Cleveland Graphite Bronze Co. of Cleveland joined the competition in 1936, and in 1939 The Raybestos Division of Raybestos-Manhattan, Inc. became the first of the old-line friction producers to manufacture sintered metallic friction materials.

In 1939 this industry had a total business of something less than $2,000,000. With the threat of war, then with the actual coming of war, however, sintered metal friction material found a bonanza of business. The product was a "natural" for wartime heavy-duty service, where long life and ability to absorb abuse are all-important, and price only something to be renegotiated later. Sales rose abruptly from less than $2,000,000 annually to the present $20,000,000 annual rate.

Consumption of metal powders, of course, followed the trend of sales. The industry's 1939 consumption is estimated at less than 350,000 lbs. of copper, 35,000 lbs. of tin, and 70,000 lbs. of lead. Current consumption is estimated to be approximately 3,000,000 lbs. of copper, 300,000 lbs. of tin, and 600,000 lbs. of lead. This quantity may seem puny in terms of total production of these metals, but in terms of production of metal powders it constitutes a relatively high percentage of this product.

Applications—War and Post-War

The friction material industry is justly proud of its war record in the manufacture of vital aircraft and ordnance equipment. It has made impeller drive clutch discs and plates for airplane engine superchargers, airplane brake lining discs, tank turret brake lining, tank master clutch rings and ring segments, tank cone brakes, automatic transmission plates for tanks, tractor steering clutch facings, earth-moving machinery steering clutch discs and brake band segments.

Many people have displayed an interest in the post-war uses that sintered friction materials may find. The peace-time sales field may be divided into three groups: First, the passenger car and light truck field; second, the medium and heavy trucks, buses, and a large fraction of the industrial applications; third, the farm equipment, earth-moving machinery, and heavy-duty industrial applications.

The first group, covering primarily the requirements of the passenger cars and light trucks, is being very satisfactorily handled by the conventional asbestos friction material industry at relatively low cost. It would seem that the metallic friction materials will find few new applications in this field.

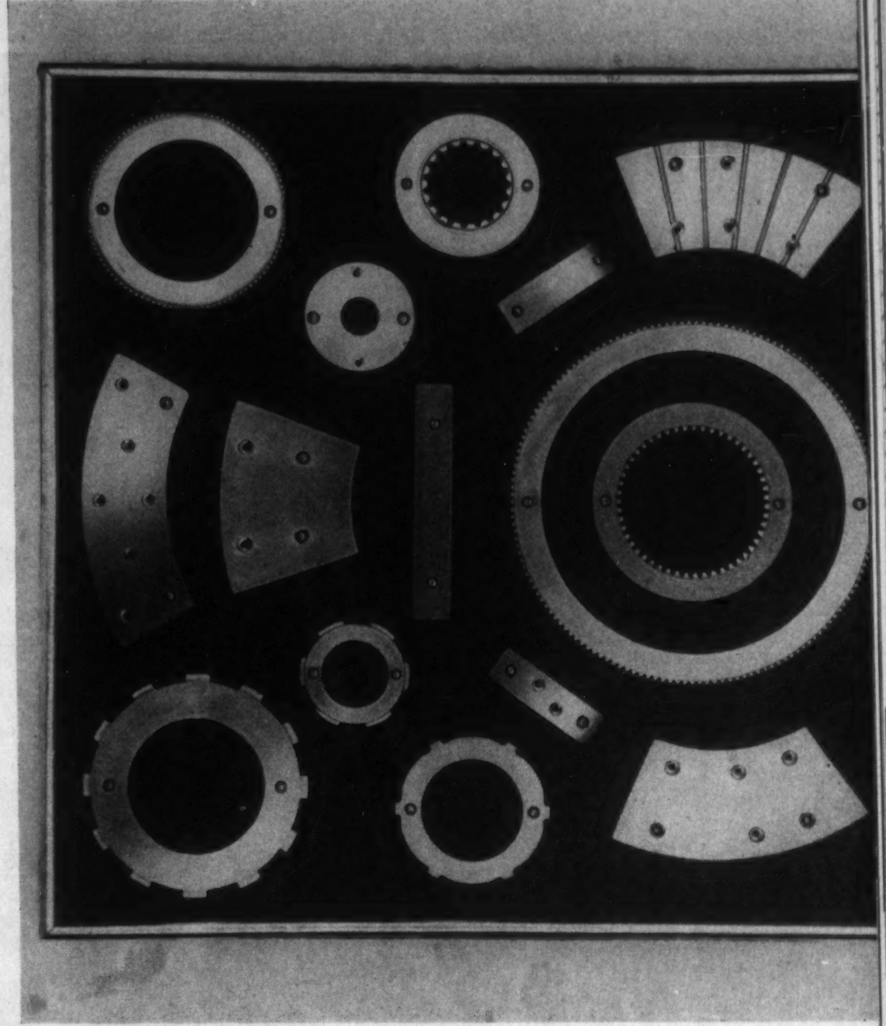
There is a vast middle ground, however, where both sintered friction material and asbestos friction material will function. The decision here will usually be a close one, to be decided on the basis of performance and economy in individual applications, with the salesmen often becoming the deciding factor. The future expansion possibilities of sintered metallic friction material lie mainly within this large field. Improvements are being made continually in metallic friction materials, and without a knowledge of the asbestos industry this field might seem to be a "soft touch."

Here we need a word about the asbestos friction industry. When developing a product the development engineers of this industry call upon the resin manufacturers for resins with specific properties, and usually get them, with technical data regarding their individual characteristics. The resin industry recognizes that it is an over-expanded industry, and is using its technicians to adapt wartime discoveries to post-war products. Improved heavy-duty non-metallic products will enter competition in this field. It can definitely be stated that the conventional asbestos fabricators, and their allies, the resin producers, understand the danger of infiltration into their field and will fight to retain the business.

Aid from the Powder Producers

Not much has been said about the physical properties required of the metal powders used in sintered friction materials, primarily because there is little to tell. The influence of the size grading and particle shape of the powders on the molding properties is well known. Copper is the key element which controls ease of molding and wafer quality.

A survey of copper powders available for the industry's use will show that each supplier has two grades of powder which will fabricate satisfactorily. One is the standard powder selling for, say, 20c per lb., and the other is a premium powder selling for 15 to 20% more. The lower-priced material will do the job, but produces a high percentage of defective wafers. Some of the premium powders have excellent molding characteristics which give low wafer breakage, even when thinner wafers are molded, but improvement is not enough to warrant premium price.



Typical shapes and sizes of friction-material parts produced from metal powders.

The resin and metal powder industries have been compared here simply for post-war background, and the metal powder producers should not assume any complaint about the lack of technical help from them. However, when you request technical help from the metal powder producers, whom do you get? You get either the sales manager or the president of the company. I haven't anything against presidents, but I ask you—"When you have a fire, whom would you want to respond to the call—the fireman or Fiorello LaGuardia?"

Previously it was stated that the division of business in the overlapping competitive fields would be on the basis of performance and economy. The fabricators of sintered metal can make articles which will compete on the basis of performance but will be hard put to compete on the basis of economy. For many products, the cost of the metal powders is 50% of the sales price, leaving 50% for fabrication, sales expense, and profit. The metal powder producers can widen the field of sintered friction materials by striving to produce cheaper metal powders with better molding properties.

The metal friction industry rests on a firm foundation of past and present accomplishment. Such a young, virile, aggressive and versatile industry as it has indicated itself to be will be an increasingly great factor in the friction materials field, and will continue to consume large quantities of metal powder.

A Methods Article One of the best examples of cast iron's serviceability as a heavy-duty engineering material is its increasing use for crankshafts. Not the least important factor here is its machinability and general ease and economy of working, all of which are graphically demonstrated in this picture story of the casting operations carried out by Farrel-Birmingham and the machining operations done at York Corp. to produce Meehanite crankshafts for York compressors and similar equipment.

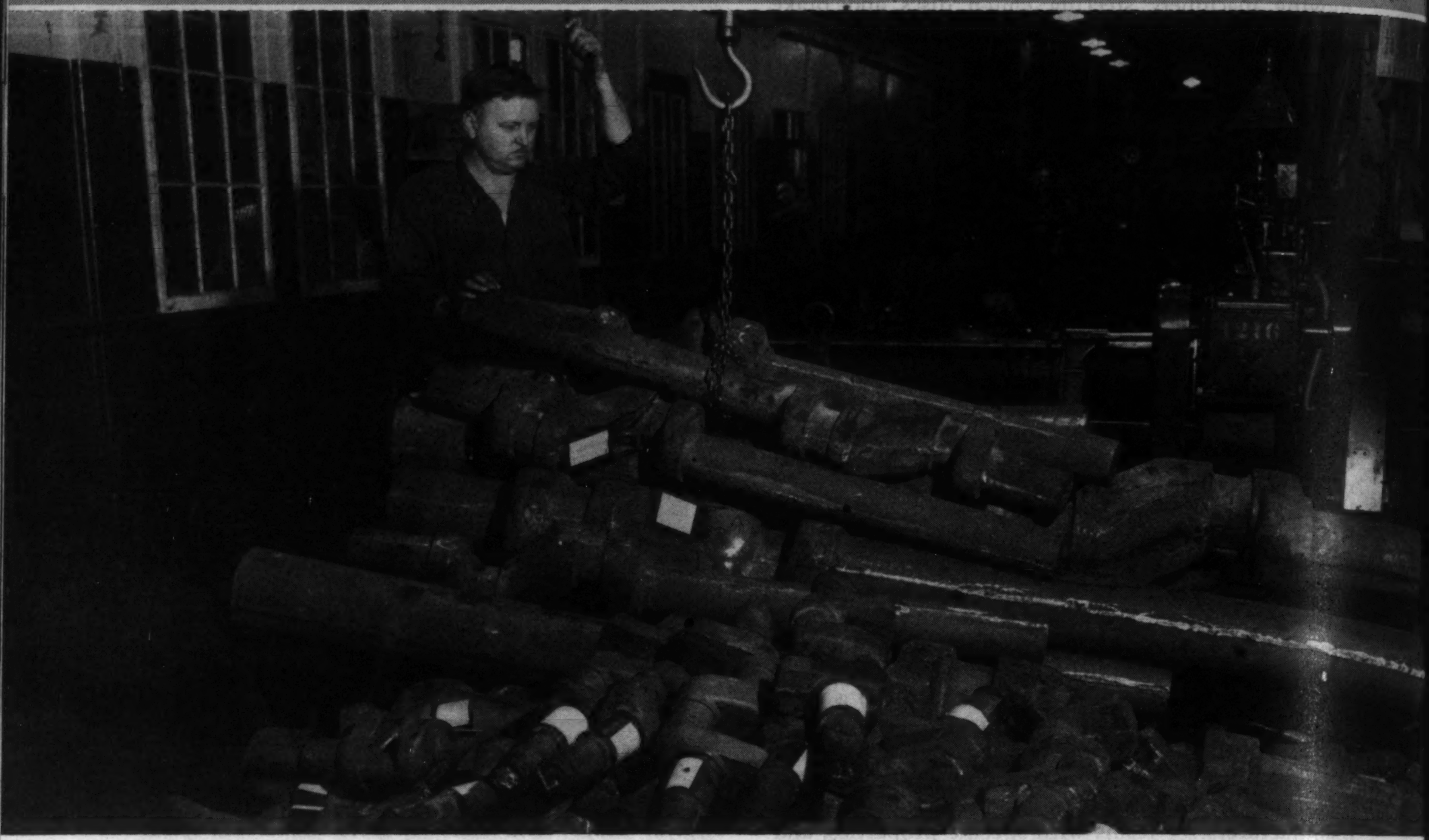


Fig. 1. A collection of cast crankshafts in three sizes (1200 lbs., 270 lbs. and 70 lbs.) ready for shipment from Farrel-Birmingham to York.

Casting and Machining Iron Crankshafts —A Pictorial Description

by J. G. BERGDOLL

General Works Manager, York Corp., York, Pa.

FROM THE STANDPOINT of the materials engineer the heart of a compressor is its crankshaft, for the crankshaft is the element that must carry the greatest loads under complex service conditions. Not only should it dampen vibration and resist fatigue stressing but it must also withstand tensile, compressive, impact and torsional stresses and carry bearing loads without excessive wear or failure.

Years ago no sensible engineer would have specified any type of unalloyed cast iron for service like this, for "cast iron" was a brittle material, good for sashweights and stoves but carefully to be avoided for heavy-duty service. Today however, there are several types of cast iron that are ideal engineering materials for many jobs, and compressor crankshafts are far from the only machinery parts in which they are being successfully used.

In the case of York's compressor crankshafts a general shift from steel forgings to cast Meehanite shafts was made early in the war period, not only because steel forgings became very hard to get but also because cast crankshafts provided sorely needed design flexibility. Compressor speeds were going higher and higher and required finer dynamic balance, something that often had to be achieved by last-minute corrections. The ease of casting-in balance counterweights for cast crankshafts was a major factor in the decision to swing over to the cast design.

Beyond all that the mechanical quality of high-strength cast iron has been all that good engineering could ask for this service. The Meehanite GM iron used has a tensile strength greater than 55,000 p.s.i., a modulus of elasticity of 23,000,000 p.s.i., a Charpy impact strength of 8.0 ft.-lbs. and Brinell hardness (as cast) over 217. There has not been a failure of one of these cast crankshafts in over three years of use, and thousands have been placed in service.

Many of the Meehanite crankshafts for York Corp. equipment are made at Farrel-Birmingham Co., Inc., Ansonia, Conn., one of the group of foundries specializing in the production of these irons. A feature of this foundry's practice is the use of the Randupson cement-bonded silica sand molding process in addition to the usual Meehanite processing technique. The York Corp. receives the rough castings and performs the machining and grinding operations that make them into finished products.

The various steps in the manufacture of the cast crankshafts are pictured in the accompanying photographs. The crankshafts cast for York by Farrel-Birmingham range from some that weigh 70 lbs. to others weighing more than 1200 lbs. This particular story is chiefly that of a typical large-size crankshaft.

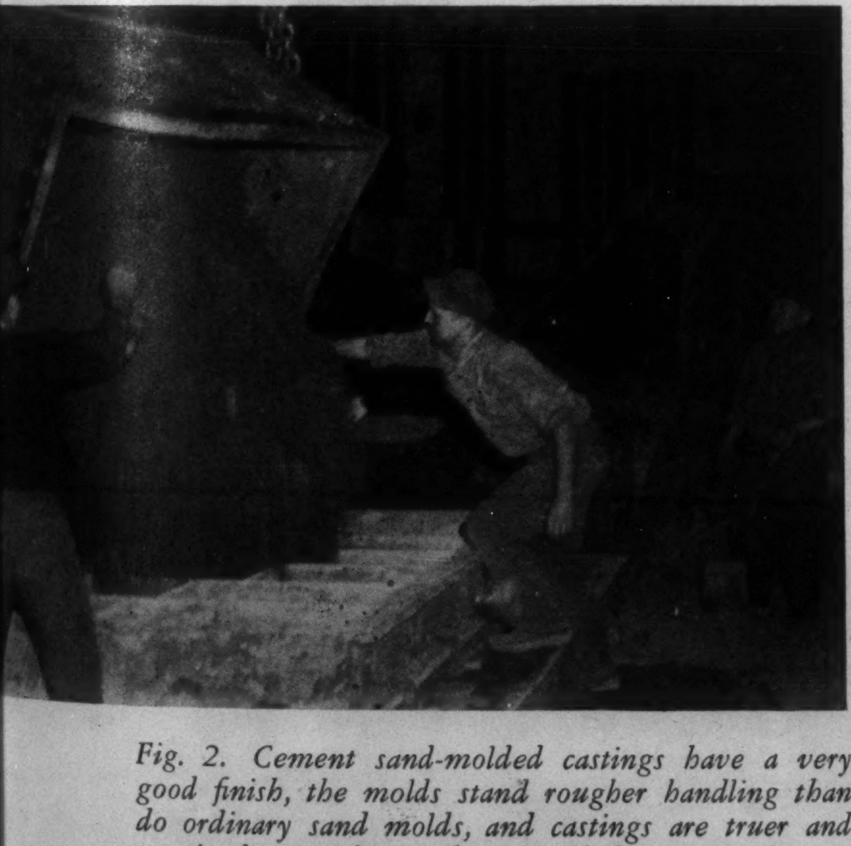


Fig. 2. Cement sand-molded castings have a very good finish, the molds stand rougher handling than do ordinary sand molds, and castings are truer and require less machining because of the warp-resistance of the mold. This photo shows the sand box containing the mold mixture being dumped into the flask holding the pattern.

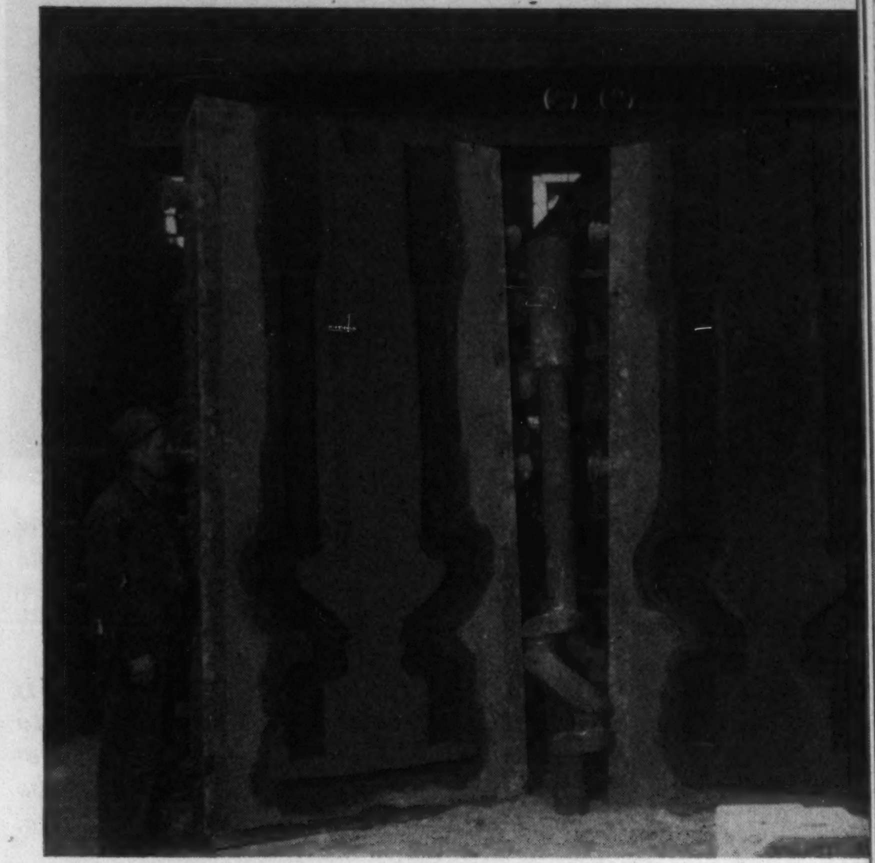
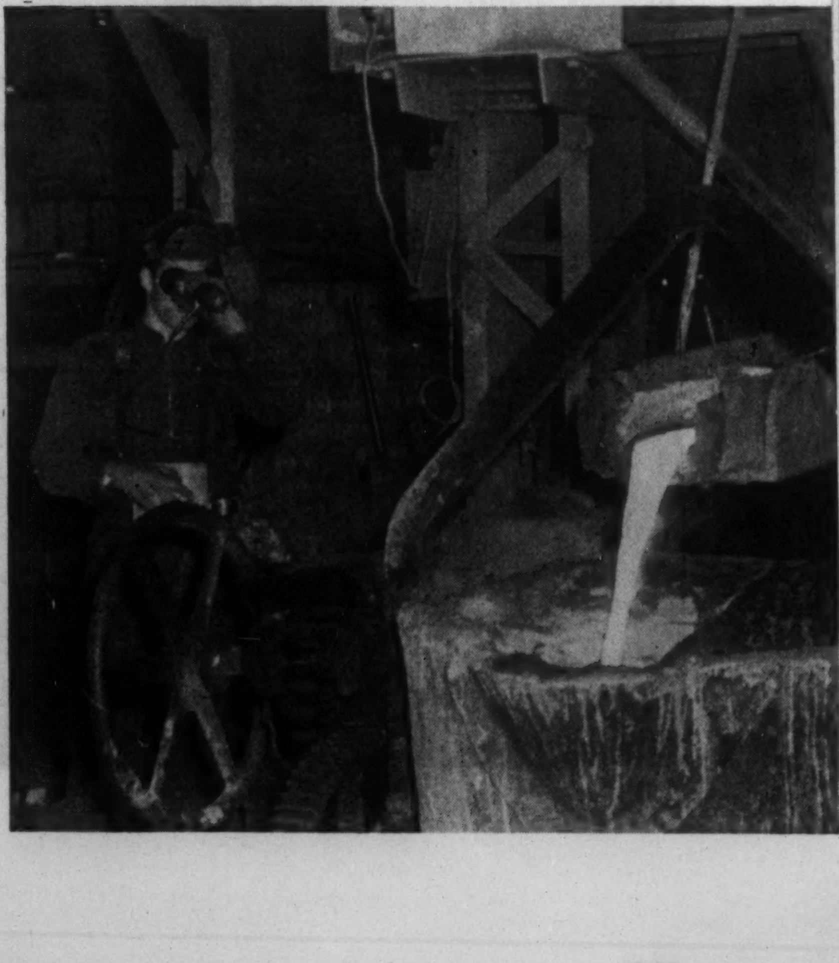


Fig. 3. After ramming, the cement-bonded sand molds are blackened and then "cured" by air-drying for 72 hrs. Here are shown the cope and drag of a double mold for large crankshafts, with one of the shafts standing between them.

Fig. 4. The iron is made in cupolas using air-weight-control blast (not, however, dried or preheated), then tapped into a preheated ladle while its temperature is checked optically, as pictured here.



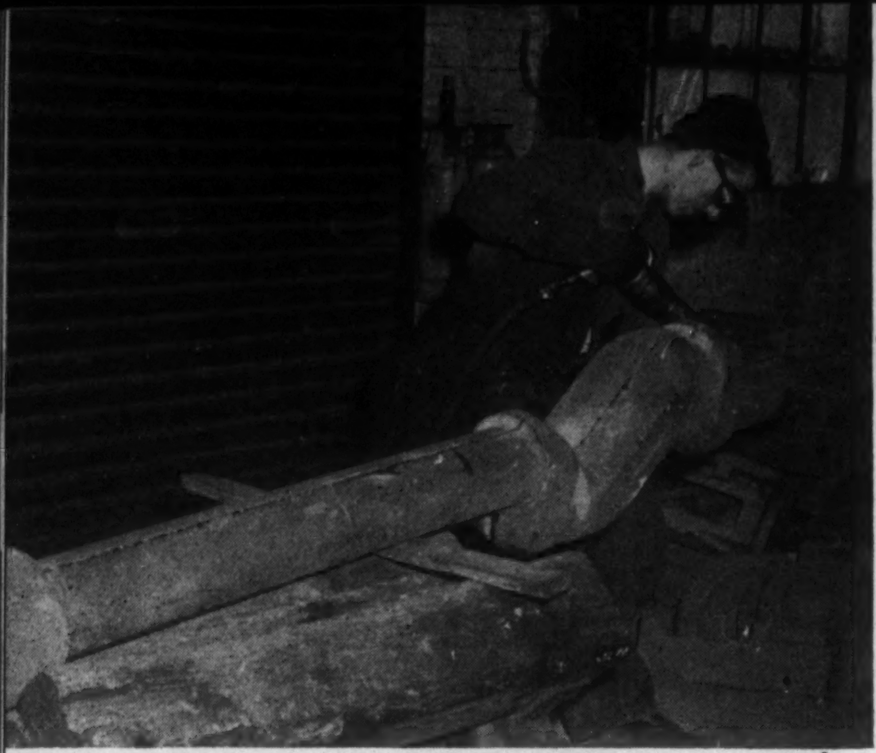


Fig. 5. Sand removal is easier with cement-sand molds than otherwise. Here the surface of a rough casting is being cleaned up with a portable snagger, prior to shipment.

Fig. 6. At the York Corp. plant full advantage is taken of the relative accuracy of the castings (due to cement-molding) and of the machinability of Meehanite. One of the first operations is turning the main bearing and facing the throw, illustrated here.

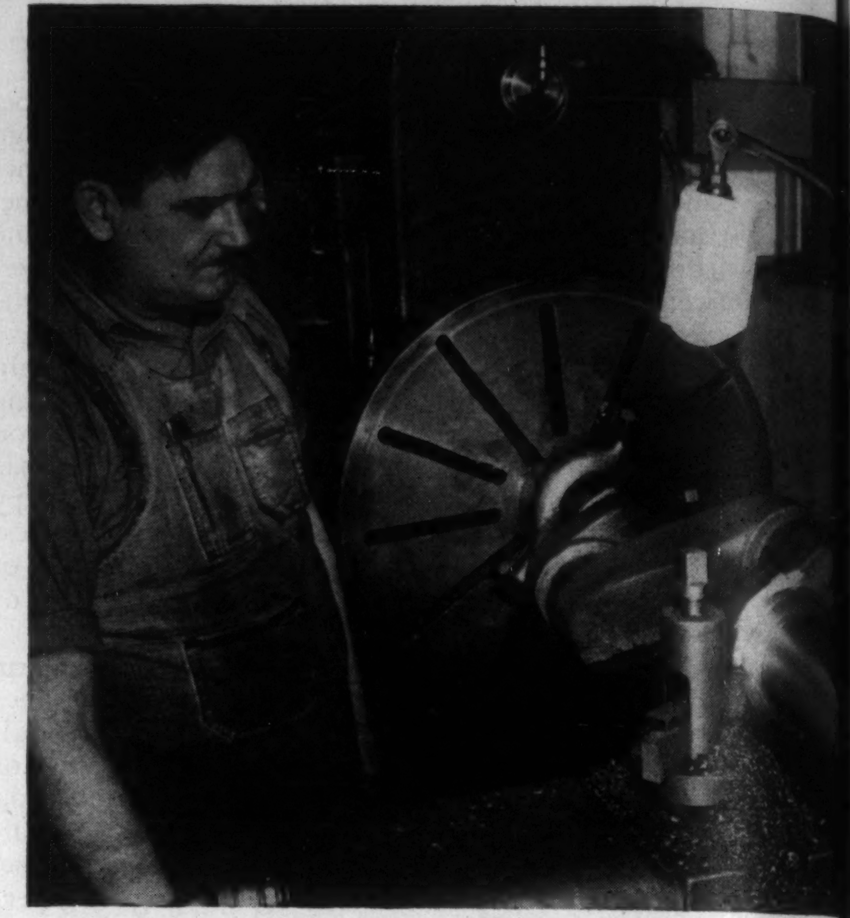
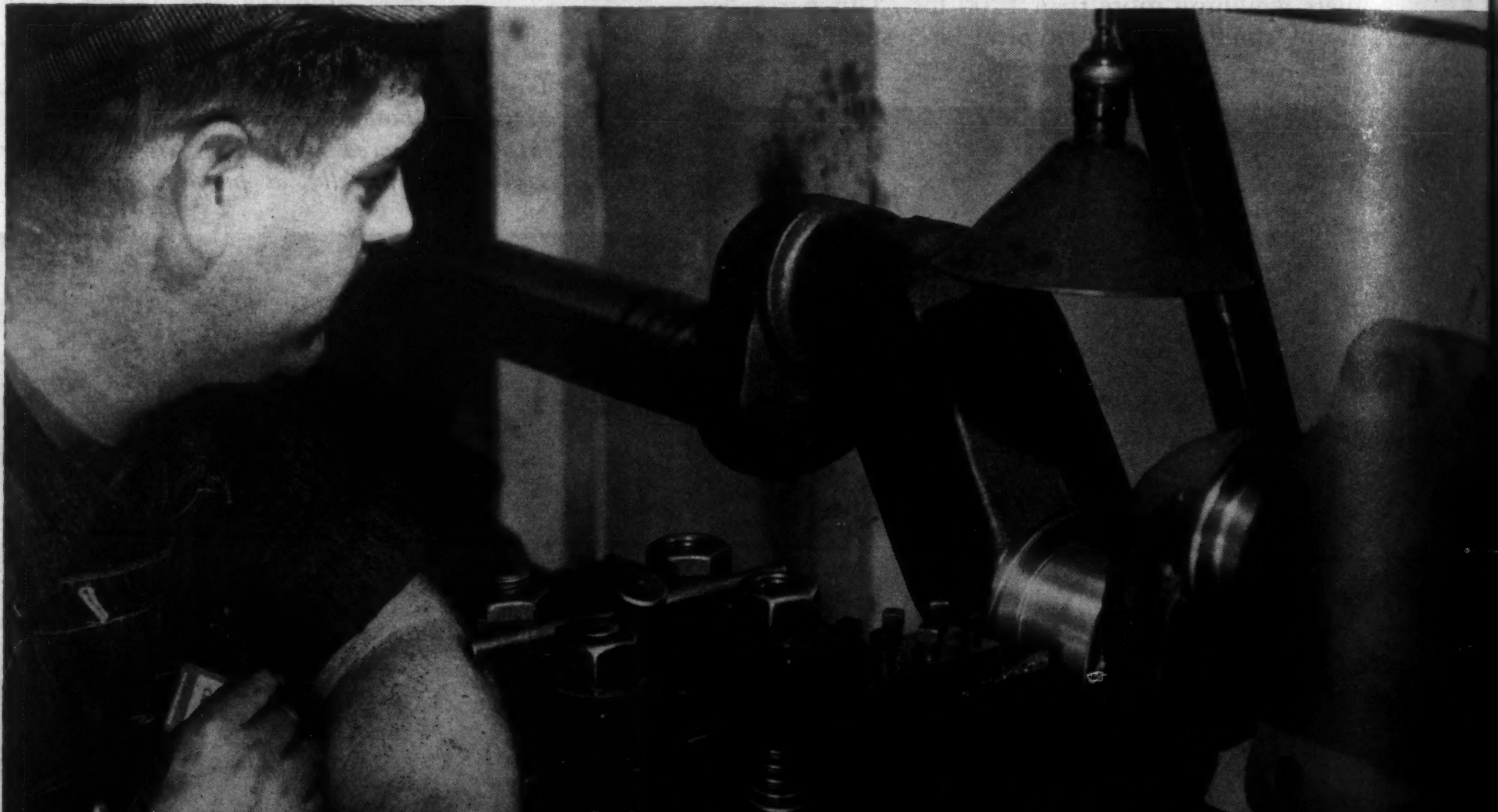


Fig. 7. Next comes the turning operation on the crank pins. Carbide tooling is used for all turning, whether roughing or finishing. Speeds are 120-150 surface ft. per min., with cuts 1/64 to ¼ in. deep and feeds of 1/32 in. per revolution.



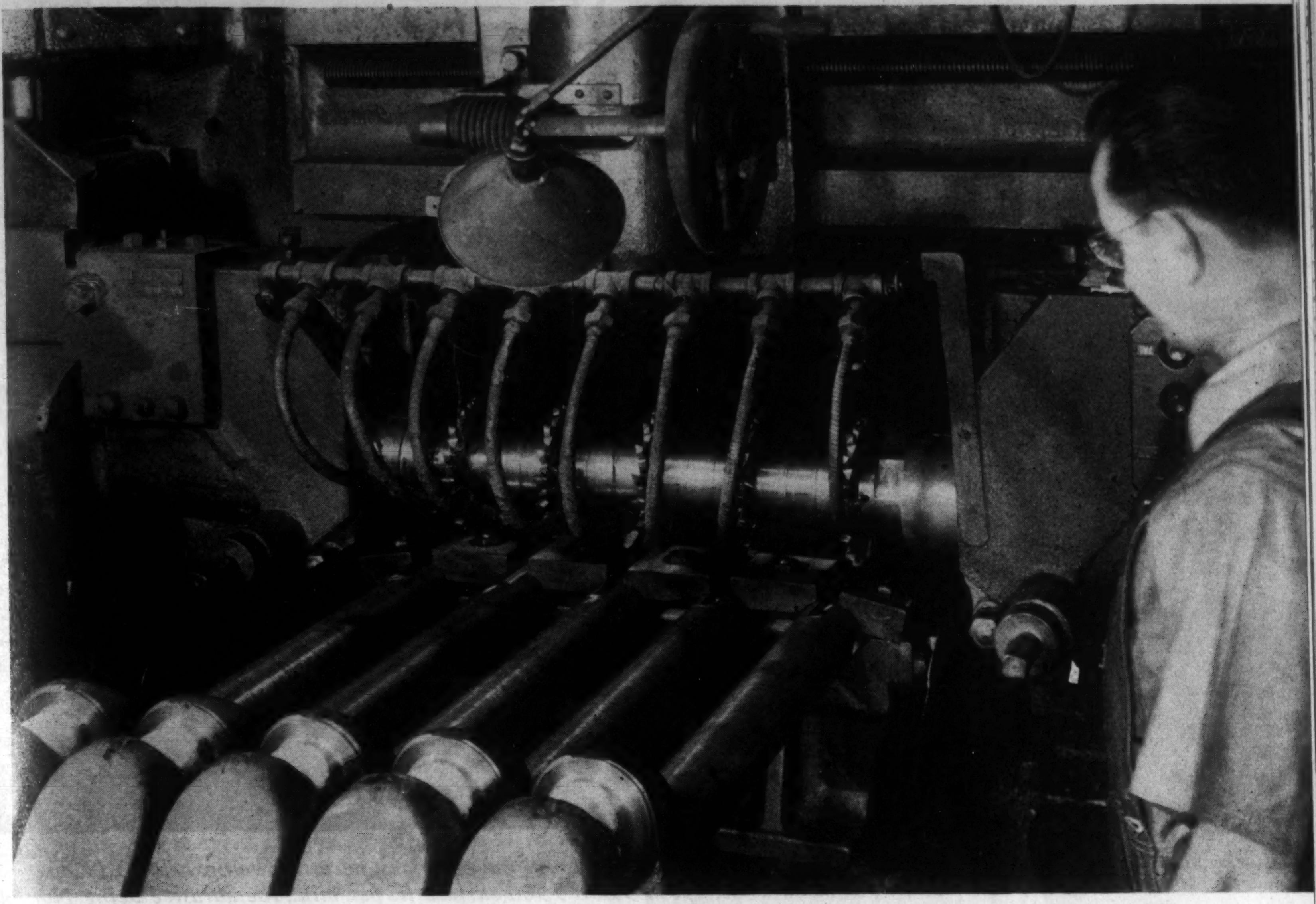
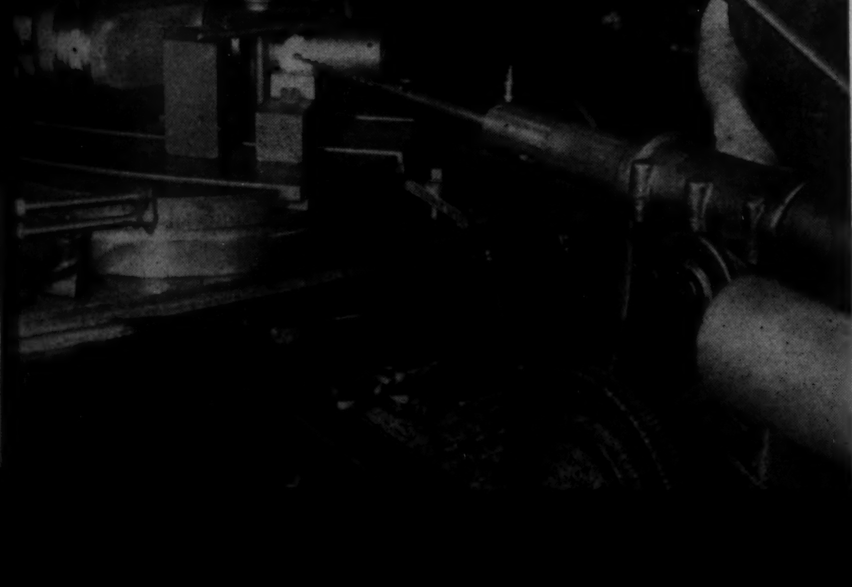


Fig. 8. This milling machine cuts keyways in 5 crankshafts simultaneously. Milling cutters are high speed steel and speeds 40 to 60 surface ft. per min.

Fig. 9. A feature of the York compressors is the method of lubricating the bearings and pins through holes in the shaft. Here one of the lubrication holes is being drilled (high speed steel drills are used) through the end bearing and the web to the pin. Other lubricating holes are similarly drilled in the shaft to make an interconnecting network passing oil from the end bearing to the pins to the main bearing.



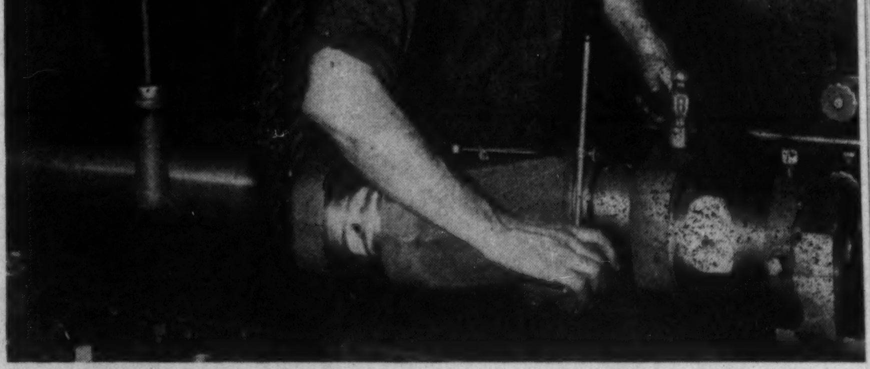


Fig. 10. Before finish grinding the crankpin in the shaft is positioned and aligned to the throw blocks and the center holes.

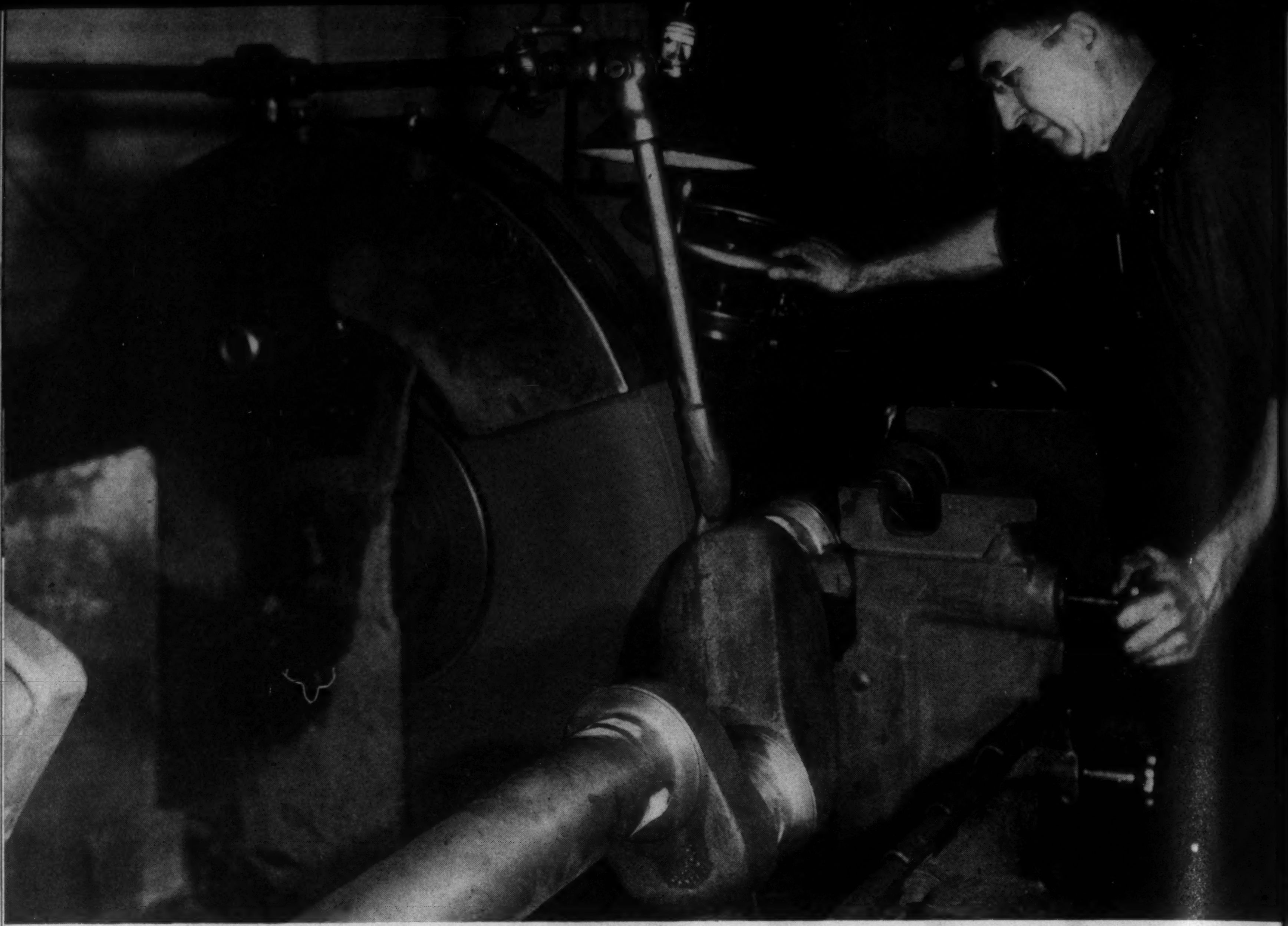
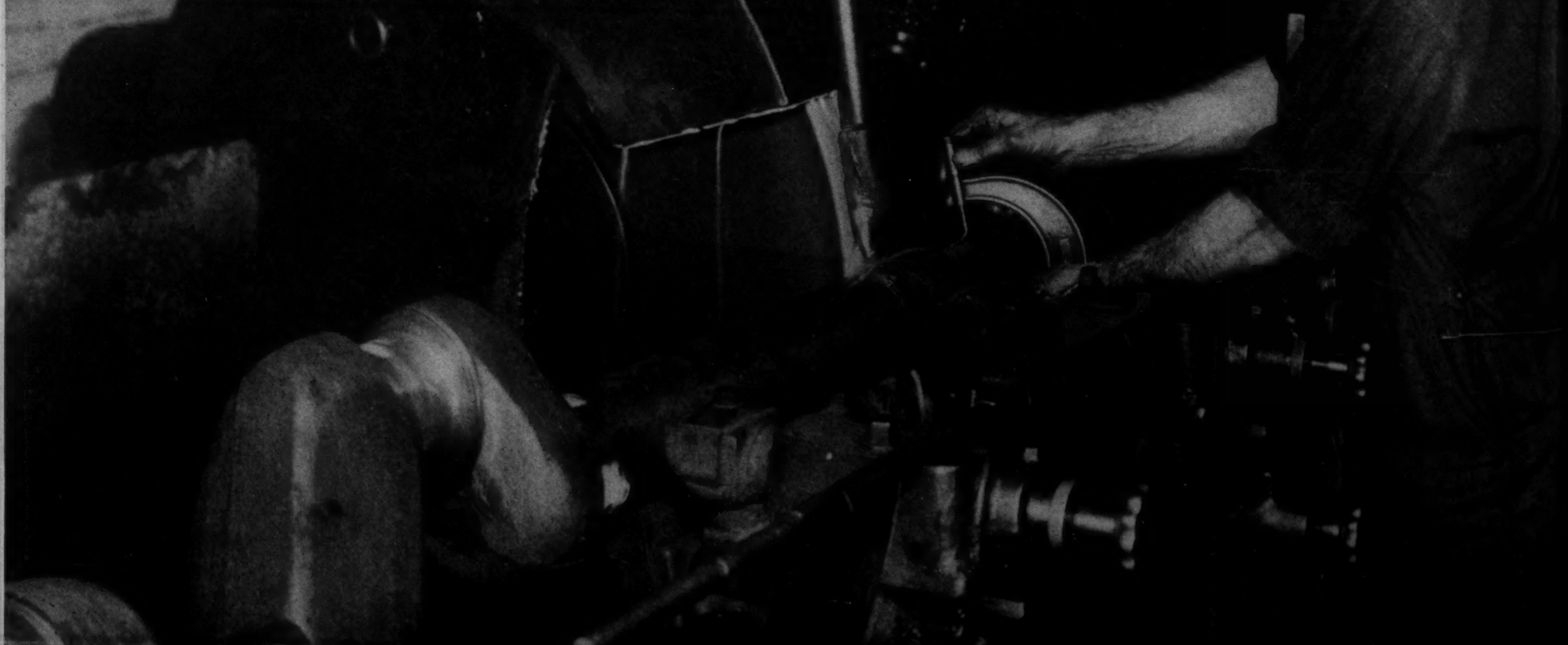


Fig. 11. Finish grinding of the pins is a precision operation, dimensions of necessity being held to 0.0005 in. Work speed is 31 surface ft. per min., wheel speed 5,000-5,500 surface ft. per min., the abrasive being Norton 24-C-M Alundum. The traverse is 1⅛ in. per revolution of the work for rough grinding and ½ in. per revolution of the work for finish grinding.

Fig. 12. The finish grinding operation on the main bearing concludes the production machining of this Meehanite crankshaft.



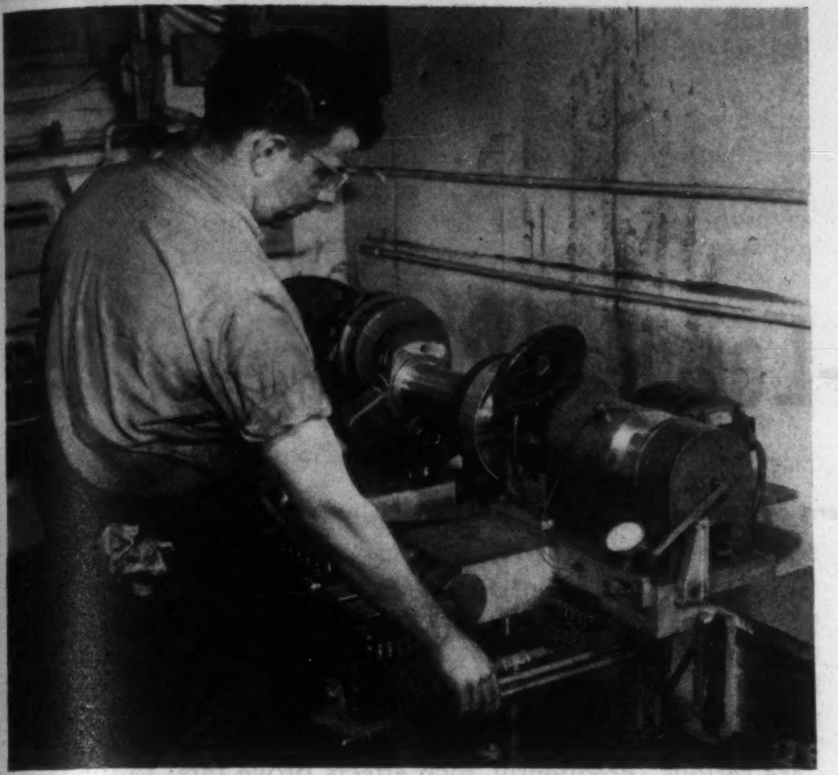
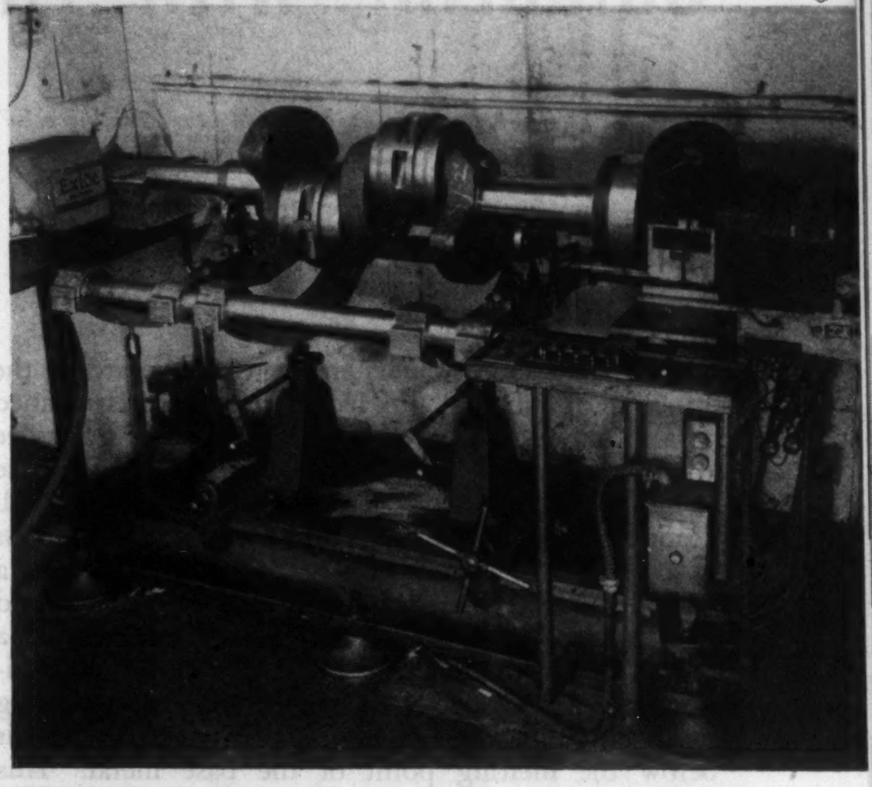


Fig. 13. To eliminate excessive vibration, which might cause fatigue failures (and too much noise) and lead to rapid wear and damage to bearings, crankshafts for high-speed service are balanced dynamically on Tinius Olsen balancing machines, one of which is shown here. Bob-weights are added to the crankpin to match the piston and connecting-rod weights and the machined shaft is mounted in the tester revolving at about 250 r.p.m. while the amount of unbalance is determined.

Fig. 14. This is a closeup of a bob-weighted crankshaft in place on the dynamic balancing machine. The machine is revolved and the amount of unbalance adjusted to balance by means of a compensating weight on an adjusting screw and operated by means of an angle slipping clutch, which enables the operator to position the compensator in the right location to counterbalance the amount of unbalance angularly and radially. On the basis of these readings metal is added or removed to place the shaft in perfect balance.



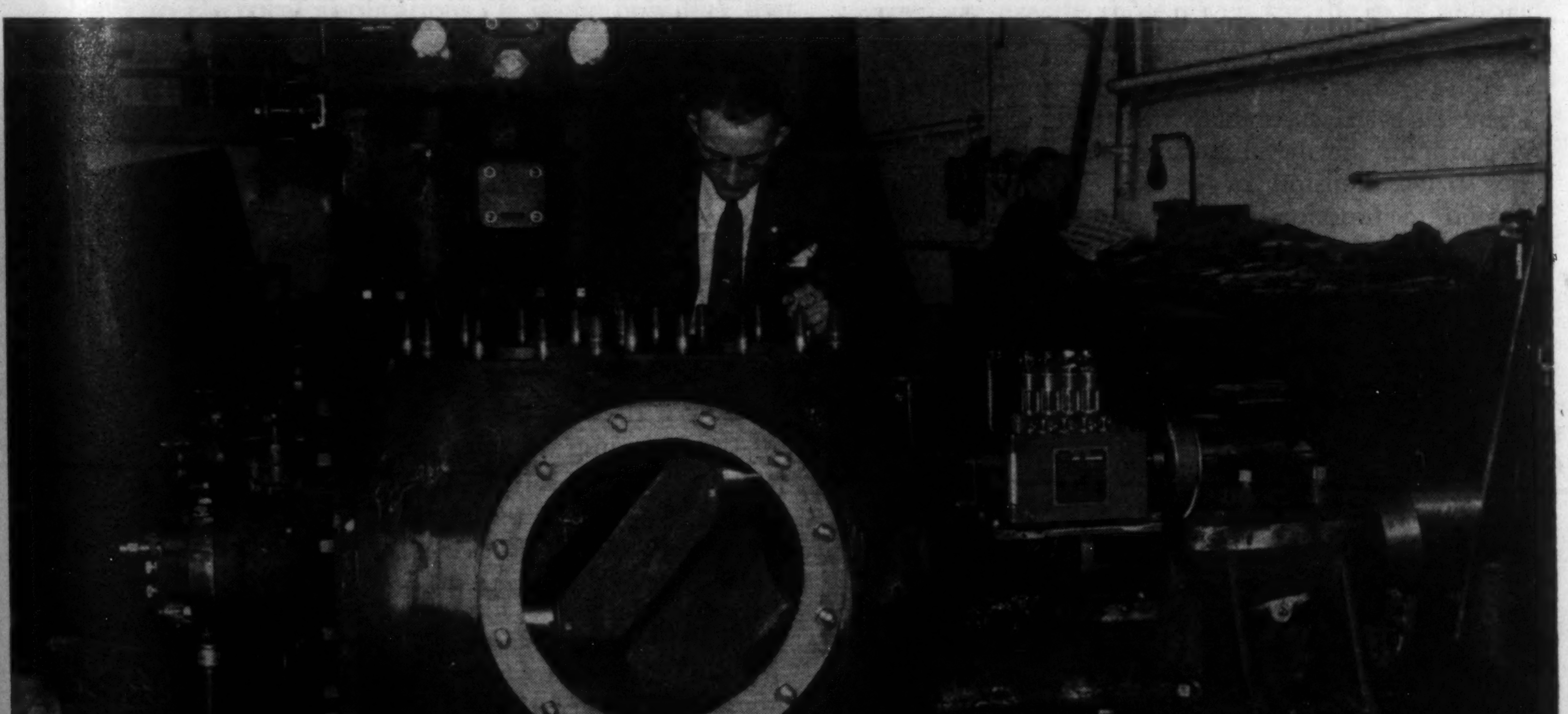


Fig. 15. With obvious admiration one of your hosts gazes upon the Meehanite crankshaft finally installed in a York 2-cylinder vertical enclosed ammonia compressor, ready for years of heavy work.

A Materials-and-Methods Article Continuing from our March issue his intensive and instructive examination of good and bad practice for soldering with the low-tin lead alloys, Mr. Mample discusses this month fluxes, soldering devices and the mechanical quality of soldered joints, and presents a useful summary of the whole problem and practice for design, materials and process engineers.

An Engineering Approach to

Soldering with Tin-Lead Alloys—Part 2

by A. Z. MAMPLE *Assistant to Lines Engineer, Western Union Telegraph Co., New York*

Functions of a Flux

Considerable misunderstanding exists regarding the function of a flux. A flux has been quite often defined as a substance whose function is to clean and dissolve the metallic oxides, etc. from the surfaces of the base metals. Since there are many chemicals which will readily clean metal surfaces and yet are totally useless as fluxes, such a definition at best could only be a partially true statement. When it is further realized that an analysis of a soldered joint often reveals a solder alloy which includes the base metal, the definition appears hopelessly deficient, since the soldering temperature may be a few hundred degrees Fahrenheit below the melting point of the base metal. This shows that a good soldered joint is more than an adhesion and that a good flux does more than "clean off the oxides".

A flux then may more broadly be defined as an active chemical substance which serves to clean and to maintain the metal surfaces so as to either lower the surface tension or enable the normal surface tension to function in promoting the wetting and alloying of the metal surfaces with molten solder. A flux thus has five functions in the soldering operation as follows: (1) To clean the surfaces; (2) to prevent oxidation of surfaces at elevated temperatures; (3) to lower the surface tension or to enable the normal metal surface tensions to function; (4) to promote alloying of the metal surfaces with the solder at soldering temperature; (5) to promote wetting of the metal surfaces by molten solder.

A flux may, however, perform all of the above functions and yet not be a good overall flux. To be a good overall flux, the flux residue must be non-corrosive, non-conducting (electrical), and non-hygroscopic. In addition, a flux should not readily volatilize, decompose or carbonize at normal soldering temperatures.

Fluxes have always been an important factor in the soldering process, but they have become increasingly important because of the very large increase in the use of electronic and other sensitive electrical circuits where corrosion of small parts or high resistance leaks caused by the fluxes or by the flux residues are serious. Frequently, such effects prove fatal to the circuits or the equipment in which the fluxes have been employed. The reduction in tin content of tin-lead alloys due to the war have added to the importance of a proper understanding of fluxes, flux functions and the part played by flux residues. It is thought that such an understanding will lift the veil of mystery from the various fluxes and their proper functions.

Rosin as a Flux

Rosin is generally not considered as an acid type flux, but this is not true. Rosin does contain an acid, but it has certain rather unusual physical properties which prevent the acid from being active at normal temperatures. Furthermore, the residue of a rosin flux is non-conducting, non-corrosive and non-hygroscopic. Because of these properties rosin has often been referred to as the ideal flux. On the other hand, the erratic results often obtained have given rosin a questionable standing among the fluxes. Study shows, however, that there is little deficiency in rosin when used properly and that the erratic results are due to the destruction or impairment of its fluxing properties by improper use.

One of the frequent errors in handling rosin is that of over-heating. Rosin is affected by heat, light, age and atmosphere, but practically excess heat is the only factor which can seriously affect the work. Too much heat disintegrates the rosin and reduces its active fluxing properties. Further over-heating will completely destroy the fluxing properties and will carbonize the residue as well. The first step in eliminating this error is to follow the rule that rosin should always be applied to the parts being soldered and not to the soldering iron. Rosin core solder should not be applied to the hot iron with the idea of later transferring both the flux and the solder to the joint. The excess heat will reduce and perhaps destroy the ability of the rosin to act as a flux and if it carbonizes, the iron shortly becomes so heavily encrusted as to be unsuited for good work.

Since it is evident that if the parts are over-heated they, like the iron, may damage or even carbonize the rosin, a further rule to follow is that the rosin core solder should be applied to the parts as they are being brought up to the soldering temperature, not applied after they have reached a temperature approaching that of the soldering iron. Good practice involves efficient heat transfer through the medium of the solder itself.

Our tests showed that a low soldering temperature of 550 F will volatilize about 7% of the rosin. As 550 F is only slightly above the liquidus point of some solders, it is evident that proper cognizance of soldering temperatures will solve many production difficulties.

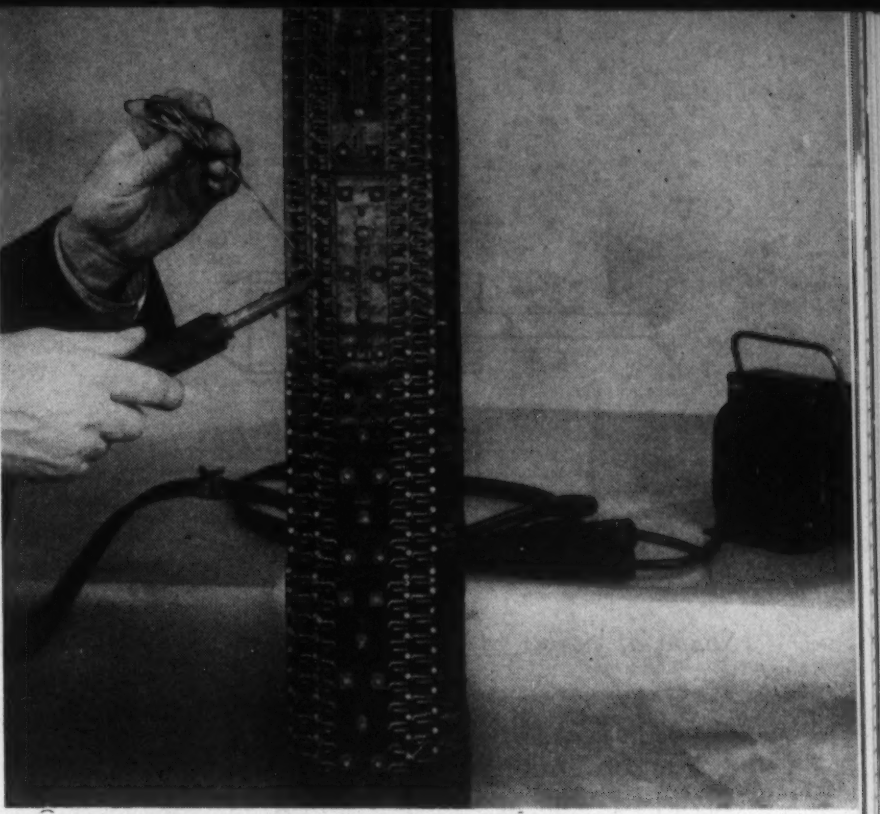
From the foregoing it should not be assumed that a "cold" soldering iron is preferable or even can be tolerated. If the joint is heated slowly there may be time for the heat to travel back, for instance into rubber insulation, releasing pernicious fumes or even melting it. All of the steps recommended above can be taken with a reasonably hot iron, the upper limit of iron temperature being where it will not itself oxidize or become coated with carbon-like matter too rapidly. (See General Soldering Devices.)

A trouble sometimes met with is the so-called "rosin joint," a joint that looks sound and possibly has adequate strength, but which is deficient in electrical conductivity. The most common, possibly the only, cause of rosin joints is a coating of sulphide on one of the surfaces. Rosin flux will not effectively remove a sulphide coating. Trying to force the situation with higher temperature will not help and will shortly impair and finally destroy the fluxing properties of the rosin.

Rosin should, in general, be used as the standard flux in electrical applications. It is the only flux that should be used on any part of sensitive electrical circuits of any type. This is particularly true of electronic and similar type circuits. Other fluxes, such as paste type fluxes, may be required in special applications such as in soldering lugs on power cables or wires, sweating parts together, soldering long seams, etc., but even in many of these applications rosin may be effectively used if applied in the manner specified.

Some Other Fluxes

Salt or "acid" type fluxes are the chlorides of ammonia, zinc, aluminum, etc. These salts are a combination of a weak base and a strong acid. The salt type of fluxes has two valuable characteristics. They are very active as a flux under the normal conditions of soldering, and they do not carbonize under high temperatures because the salts are inorganic. The unfavorable characteristics of the salt type which render them unsuited for all purposes except soldering on a large scale such as sheet metal work and the like, are that they are highly corrosive, electrically conducting, hygroscopic, and the residues have all of the unfavorable characteristics of the flux. Further, this type of flux does not flow with heat or permit the hot solder to flow, so they cannot be effectively used in a sweated type of joint. Finally, the flux residues are not easily removed.



Soldering with a carbon electrode device.

The paste type fluxes are emulsions of solutions of the salt fluxes just described. Besides the favorable characteristics of potency and non-carbonizing which are inherent in the salt fluxes, the paste fluxes have the further advantage that they readily flow ahead of the molten solder, cleaning and protecting the surfaces. This is true even though the "dispersing phase" (the grease of other material holding the salt solutions) may be chemically inert. While this ability to flow ahead of the molten solder is a necessary characteristic in a sweating operation, it is undesirable in soldering to terminals, connections, etc., where the spread of the flux and solder should be restricted or is unnecessary. The unfavorable characteristics of the pastes are exactly those given for the salts although, in general, they are present to a less damaging extent.

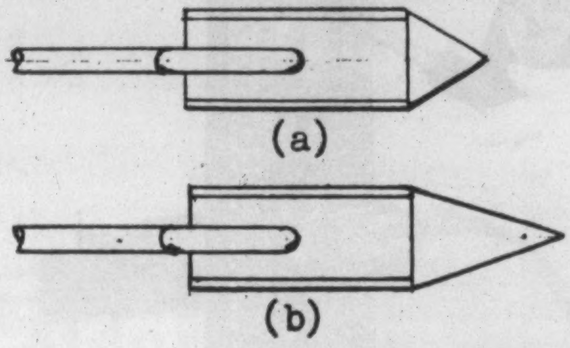
Paste fluxes may be used to a limited extent in soldering seams, soldering on lugs, sweating parts together and in power wire work where the ensuing high resistance leakage or corrosion is unimportant. It can well be used in pre-tinning (pre-soldering) operations followed by cleaning off residual flux and assembling the parts by soldering with rosin flux.

The wax type of fluxes consists of a group of the organic acids such as stearic, oleic, tartaric, benzoic, etc. They are corrosive but not so much so as the inorganic salt type. They are also somewhat electrically conductive. The only significant usage of this type of flux is in connection with special applications such as, for example, soldering on lead.

General Soldering Devices

Coming now to the apparatus used in soldering, in order to bring the parts to a suitable temperature, there may be set up five usual types:

1. Conventional type soldering iron.
2. Electric soldering iron.
3. Gas-heated soldering iron.
4. Carbon electrode soldering unit.
5. Open flame or torch.



Shape of points of conventional-type soldering iron.

Conventional Type Soldering Iron

The conventional soldering iron is a mass of copper equipped with a heat insulating handle. It is an efficient, inexpensive, flexible and simple device. It may have a variety of sizes and shapes, but customarily is pointed as shown above. A good rule here is that the point should be as short as practicable; (a) above is basically a better design than is (b). A stubby iron with a short point transfers heat to the joint more effectively because there is less distance to travel and a greater cross-sectional area to travel in. Less heat is lost by radiation to the air and when the iron is being heated there is less likelihood of the point overheating and becoming "burned," that is, losing its bright tinned surface. Of course, the nature of the work being soldered often requires departure from these ideal conditions. In heating the iron, the flame should always be placed under the body of the iron [(a) in lower sketch on next page] and never allowed to heat the point directly as (b). This, of course, is to store up heat in the body of the iron where it will do the most good in the soldering operation.

The degree to which a soldering iron should be heated is not easy to specify but it is an important part of the soldering process. There are, however, several things that can be done to assist in determining the proper temperature. One of these things is to test the point of the iron as the iron is being heated with a piece of solder wire (*not* rosin core). When the solder begins to soften, the temperature can be assumed to be about 361 F and when the 20/80 solder is completely liquid the temperature can be assumed to be about 532 F. A good soldering temperature is about 100 F higher than this point. Whenever the body of the soldering iron changes the flame to a purple color or when the body of the iron has a dull red glow when shielded from bright light, it can be assumed the iron is too hot and should be immediately removed from the flame.

A frequent mistake in the use of a soldering iron is the practice of heating an iron to a higher temperature in order to solder a larger piece of metal instead of using a larger iron. A larger iron has a greater heat capacity and this greater capacity, rather than a higher temperature, is what is needed. Higher temperatures, as before indicated, destroy the surface of the point of the iron and thus impede, rather than assist, the soldering process. Conduction of heat through a globule of solder will effect quicker work than too high a soldering temperature.

Electric Soldering Irons

The electric soldering iron is a copper point heated by a resistance unit. This tool is ideal for use where the same soldering operation requiring a uniform amount of heat is repeated many times.

An electric soldering iron differs from the conventional soldering iron in that the supply of heat, not the temperature, is constant. With the conventional iron the operator expects to give thought to the iron's temperature and to take care of heating it from time to time as required. With an electric iron, however, he expects the heating to be automatic and gives little or no thought to the iron's temperature. This requires that the electric iron be selected with some reasonable regard to the work being performed. A large iron used on small parts or with considerable periods of time between soldering operations is likely to over-heat. Conversely, a lighter iron used on heavy work or to solder quite continuously, may not develop enough heat in the point to permit of satisfactory soldering. For the same reasons mentioned before, the copper in an electric soldering iron should be as short and with as blunt a tip as is convenient for the type of work being performed. These are illustrated in the upper diagram on the next page.

In order to prevent over-heating of an electric iron and to provide more flexibility than is normally afforded, a circuit arranged as illustrated on page 1004 where a suitable resistance is in series with the iron may be employed. When more heat is required, the circuit is arranged so that the resistance may be short-circuited in order to bring the iron up to its maximum heat.

Gas-Heated Soldering Irons

Gas-heated soldering irons are copper points attached to a tube having an insulated handle. Combustible gas passing through the tube and suitable orifices feed a flame located inside of the iron. Since it is so little used, further discussion of the operation of the gas-heated iron will be omitted. In general, statements made regarding the conventional iron also apply to gas-heated irons.

Regarding all three types of soldering irons mentioned, certain rules apply. The most important is that the iron must be properly tinned. The point of the iron should be cleaned and shaped with a file, heated to a temperature only slightly above that necessary to melt the solder and then, with the aid of a suitable flux, the faces should all be covered so as to present a bright shining surface.

However heated, a soldering iron inevitably becomes coated with a black substance which may be oxides or carbonized residues of some fluxes, etc. These residues encroach upon the tinned point and eventually there is not sufficient tinned surface left to permit proper soldering, whereupon the iron must be re-filed and re-tinned. File irons when cold or at least when warm, but never while hot as the copper will immediately oxidize the filed surfaces.

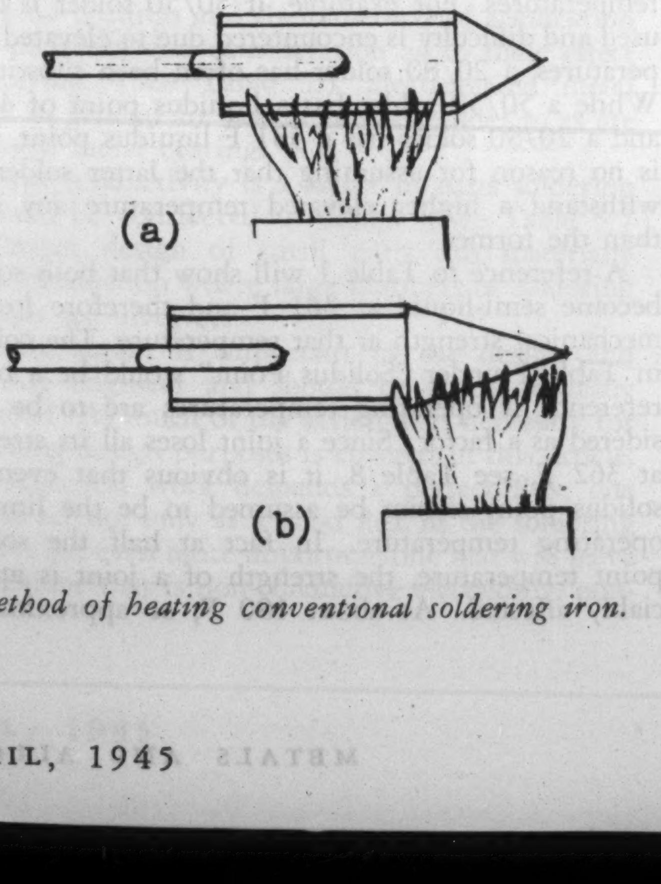
Electrode Type Soldering Device

A most convenient soldering device is finding increasing acceptance where a.c. electric current is available. It is a carbon electrode unit and is ideal for soldering relatively small parts such as connections to terminal lugs, wire joints, wire terminals and the like. A unit usually consists of a pair of rather closely spaced carbon electrodes which nevertheless are insulated from each other and are respectively connected to the terminals of a low voltage source of electric current, usually a transformer. The electrodes in the insulating holder are brought to the work which causes a short circuit between them thus passing a relatively high current through the tips of the electrodes. These are tapered to obtain a high current density where the electrodes are in contact with the work and the I^2R loss causes a rapid rise of temperature in the tips. The electrodes reach a higher temperature than does a soldering iron but, since they are not tinned, no harm comes to them. Also, since the contacts which pass the current are likewise those which transmit the heat, it is certain that the heat will travel into the part to be soldered. With this method it is easy to work with rosin core solder. Neither solder nor flux should be applied to the electrodes, but directly to the work.

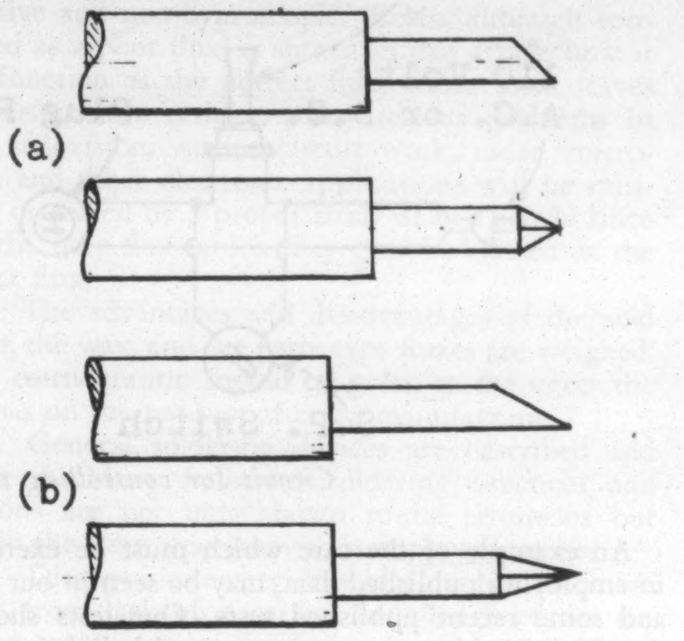
The best technique involves holding the solder against the cold work with one hand and then applying the electrodes with the other hand and holding both until the flux and solder begin to run. At that time both electrodes and solder can be removed and a perfect joint results. With the high electrode temperatures available it is easy to over-heat the work and to develop sulphur fumes from adjacent rubber insulation. If the parts were not previously covered by the rosin flux, sulphides would be likely to form and ruin the work. Hence, touch the flux-carrying solder to the work as it comes up to temperature. Production is not slowed down, but increased by following this procedure because the electrodes heat up almost instantaneously.

Soldering with Flames

For certain types of work, flame soldering can be employed. Where large pieces of metal are to be soldered requiring considerable heat to bring them to the proper temperature, a flame may be applied to the work, but preferably to one side of the part to be soldered. The flame should not be a carbonizing flame. Fluxes, particularly rosin, should not be placed directly in the flame. Like the gas-heated soldering iron, this method is not much used.



Method of heating conventional soldering iron.

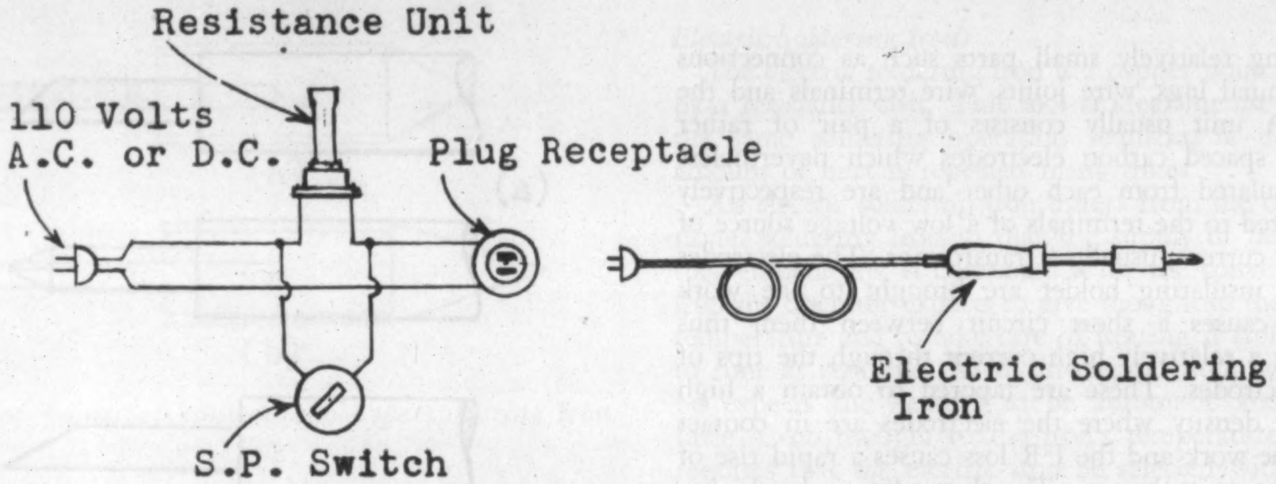


Shape of points for electric soldering irons.

Mechanical Strength of Soldered Joints

Before considering the effect which static loads, continuous loads, temperature, or the composition of the alloys have on soldered joints, it is necessary to consider the effect of workmanship. It has been shown that, contrary to general belief, tin-lead alloys do not solidify at the published so-called "melting points" of the alloys, but at the solidus point which is at a considerably lower temperature. The movement of the joint by the operator during the cooling in the semi-plastic range will generally result in a defective joint which may or may not be visible. Since different tin-lead alloys have different semi-plastic temperature ranges, reference to Table 3 will be helpful in anticipating the difference in production procedure which must be allowed for in the use of any particular alloy for a specific application. This is necessary even in cases where definite loads are not a problem, but where a permanent joint is essential.

If a joint is to be required to carry a load, the kind of a load must first be taken into consideration, since a short-time load and a continuous load present two different problems. Most data present information as to the strength of joints, but, unfortunately, they generally do not state that it is for short-time loads only. Further, the data usually do not state the temperature of the tests or the temperature at which the test values no longer hold. The data are, therefore, generally assumed to be the strength of joints similar to strength tests made on welded or brazed joints. This is not true. Further so many other factors affect the strength of joints which are neglected or ignored that much data have questionable value. These factors include the solder composition, the kind of base metal, film thickness, temperature of soldering, temperature at which tests were made, time of applied load, fillet dimension, plating on base metal, etc.



Circuit for controlling temperature of electric soldering iron.

An example of the care which must be exercised in employing published data, may be seen in our tests and some recent published tests. Our tests showed that 20/80 solder, contrary to general belief, is about as strong as 50/50 solder. The National Bureau of Standards[6] tests concurred in our findings as shown by a few of the values taken from their tests and presented as Table 7. But the Bureau of Standards' report, however, concludes that "there is little, if any, correlation between tin content and the strength of joints represented." This statement is true only if it applies to alloys having a tin content of 50 to 20%, but it does not apply to other binary tin-lead alloys nor to a number of ternary alloys. With binary tin-lead alloys, for example, the eutectic alloy (62% Sn, 38% Pb) has an appreciably greater strength than any of the alloys tested.

Hence our tests and their tests agree on strength of the two alloys shown in Table 7, but no general conclusion should be drawn from the Bureau's tests that there is no correlation of tin content and strength of joints. The apparent difference in the indicated unit strength in Table 7 is, no doubt, due to the fact that the tests included the strength of the fillet in the joint. Actually in small joints the fillet may be a large part of the strength of a joint since a fillet of one size is a larger proportion of a joint of small area than the fillet of the same size is to a larger relative area. Therefore, Table 7 appears to give a greater unit strength to the joint of smaller area than it does to the unit strength of the larger area joint which, of course, is not true, at least not to the extent shown. Thus, the 0.56-in. copper joint has an apparent unit strength of 3131 lb., while the 0.28-in. copper joint has an apparent unit strength of 4700 p.s.i.

Inasmuch as the literature does not give a correct or complete comparative picture of tin-lead alloy joints as they are affected by short time or continuous loads or as these joint strengths are affected by temperature, alloy composition and base metal, Tables 8 and 9 were prepared. These tables were prepared to give a true comparative picture. Where our test data were lacking in certain details, the data in the tables were filled in by calculations in which similar tests were used as the basis for such calculations, thus rounding out the tables, but in principle the comparative values are correct. The only factor which has not been included is the extent of creep with load and temperature. The values given under the column heading 20/80 in Tables 8 and 9 will not greatly differ from other alloys between 20/80 and 50/50 composition. Table 8 shows unit strengths of joints with short-time loads when subjected to different temperatures and compositions. The difference in joints made from different base metals is also shown.

Continuous loads are a problem with soldered joints because the anticipated performance cannot be based on the performance of other common joints as, for example, welded or brazed joints or even soldered joints. A continuous load will act differently and hold less of a load than will a short-time load at normal temperatures and a continuous load at elevated temperatures will hold less of a load than will a continuously loaded joint at normal temperatures. Table 9 was prepared as a guide for those employing soldered joints to show the relative difference between a short-time load and a continuous load. The table was also intended to show the strength of joints when subjected to continuous loads at normal or elevated temperatures and with different binary solder compositions and with joints made with different base metals.

Temperature vs. Load

Production engineers frequently substitute a solder having a higher "melting point" to overcome the weakness in a connection using a lower melting point solder when the joint has been exposed to elevated temperatures. For example, if 50/50 solder is being used and difficulty is encountered due to elevated temperatures, a 20/80 solder has often been substituted. While a 50/50 solder has a liquidus point of 414 F and a 20/80 solder has a 531 F liquidus point, there is no reason for assuming that the latter solder can withstand a higher elevated temperature any more than the former.

A reference to Table 1 will show that both solders become semi-liquid at 361 F and therefore lose all mechanical strength at that temperature. The column in Table 1 under "Solidus Point" would be a better reference if operating temperatures are to be considered as a factor. Since a joint loses all its strength at 362 F, see Table 8, it is obvious that even the solidus point cannot be assumed to be the limiting operating temperature. In fact at half the solidus point temperature, the strength of a joint is appreciably affected. At about 180 F, or approximately midway between eutectic melting point temperature, and ordinary atmospheric temperature, a short-time load can be safely assumed to be only about 20% of the ultimate short-time load at 70 F (see Table 8). Similarly at 180 F, a continuous load can be safely assumed to be only about 5% of the ultimate short-time load at 70 F.

These values are not intended to be anything more than a guide to anticipate the probable action of joints under the different conditions of load and temperature. Specific cases will require careful consideration of the various factors heretofore mentioned, but Tables 8 and 9 should definitely clarify the relative action of the binary alloys of tin and lead under various conditions of load, temperature, composition, angle of shear and base metal.

Summary

1. Tin is the most critical of metals and is the only metal that will continue to be so until after the war in Europe and until about 2 yr. after the recapture of the East Indies and Malaya.

2. Tin-lead alloys do not have "**melting points**" where the metal changes from a solid to a liquid state. Tin-lead alloys have a solid state, a "pasty" or semi-liquid state, and at the higher temperatures a liquid state. Table 1 and Table 3 give the different temperatures at which the various alloys change from one state to another and the temperature range of the "pasty" or semi-liquid state.

3. The eutectic composition and melting point temperature have been given various values. It is recommended that the eutectic composition be accepted as 62% tin and 38% lead and the eutectic melting point as 361 F. (See Table 2.)

4. Low-tin alloys do not require more heat merely because they have higher liquidus points. Tin poor alloys require less B.t.u. per pound of metal to raise them 100 F above their relatively higher liquidus points than tin rich alloys do when raising the latter 100 F above their lower liquidus points. Not only will economies be effected but much grief in production will be avoided if cognizance of this fact is taken by design and production engineers. (See Table 4.)

5. Base metals have characteristics which are overlooked but which should be given more consideration in design and production. (See Table 5.)

6. Metal coatings and their method of application should be given due consideration as to their effect on soldering. (See Table 5.) Electroplated metal coatings in general are not so good to solder to as are hot dipped metal coatings.

7. Heat conductivity is a factor in parts soldering and should be considered in design. (See Table 6.)

8. Proper design of small parts can materially increase production where large numbers of soldering operations are involved.

9. Flux action is important to the design and production engineer and should be more generally understood. As much of the action as is necessary for engineering design purposes is covered in this article.

10. Electrical work demands a perfect flux, one that will act not only as a good flux in the soldering operation but even more important, one that will leave a flux residue that is non-conductive electrically, non-corrosive and non-hygroscopic. Rosin, although considered as a poor flux, is shown in this article how it may function as the perfect flux. Since rosin leaves the perfect flux residue, many serious problems in radio, television, carrier circuit work, radar, microwave, and other electronic applications will be mitigated or solved by a proper study of this article since it is the only flux which may now be classed as the perfect flux.

11. The advantages and disadvantages of the acid or salt, the wax, and the paste type fluxes are weighed. More consideration should be given to the effect the flux has on the product after its manufacture.

12. General soldering devices are described and discussed. Many fallacious soldering practices and opinions are not only shown to be erroneous but retards the very operation it is supposed to aid.

13. Disappointment with soldering has often resulted from lack of a correct knowledge of the correlated processes of soldering rather than from deficiencies in the method.

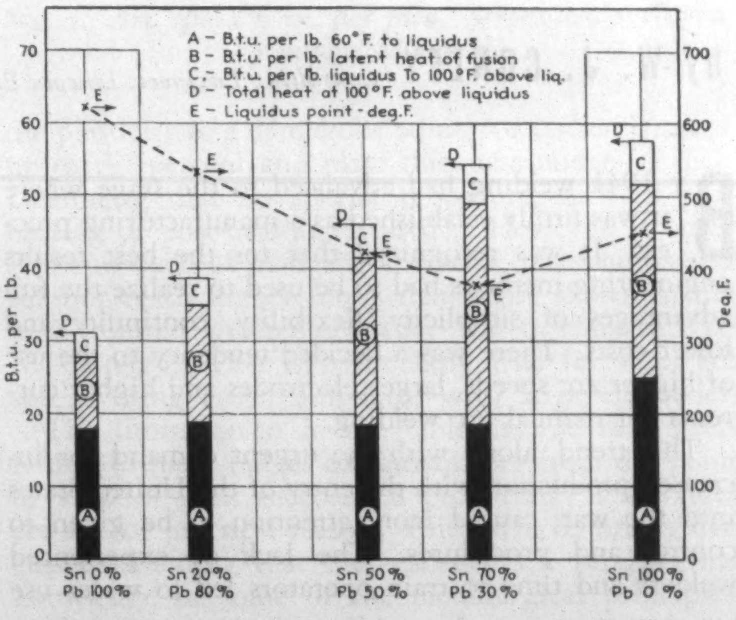
14. Mechanical strength considerations should be evaluated even though no mechanical load is involved.

15. Where elevated temperatures are involved, the "melting point" or the liquidus point should not be used as a criterion of the temperature a specific solder will withstand. The solidus point will provide a better guide as to the probable action of a specific solder at elevated temperatures.

16. Movement of any soldered connection while the connection is cooling in the pasty temperature range will seriously effect the soldered connection or joint.

17. Short time loads may be applied to soldered joints with perfect assurance if applied intelligently. Short time data found in literature should be used with caution and must be appreciably discounted when used in connection with elevated temperatures. Table 8 gives recommended maximum safe short-time loads at 70, 180, and 362 F.

18. Continuous loads require careful consideration of all factors relating to the strength of soldered joints. Table 9 gives recommended maximum safe continuous loads at 70, 180, and 362 F.



Total heat vs. liquidus point for tin-lead alloys.

19. Tin-lead alloys impart variable strength to joints. While the 50/50 alloy is somewhat stronger than the 20/80 alloy, the difference is not appreciable. Therefore, the values in Tables 8 and 9 under the column 20/80 alloy may be taken as representative of both of these alloys as well as any of the alloys containing between 20% tin and 50% tin. The eutectic alloy 62/38 may be taken as having the maximum strength of all tin-lead alloys. All other tin-lead alloys above 62% tin and those below 20% tin content may be assumed to have less strength than the values given in the two tables.

The results of the research and development work carried on by the Western Union Laboratories on ternary solders is not included because our tests seemed to support the conclusion that the 20% tin, 80% lead alloy was superior for general purpose soldering when compared to most ternary solders excepting where strength was concerned. Where greater strength in joints is desired, some of the ternary solders should be employed but higher soldering temperatures may be anticipated. The results of Western Union's research and development work in connection with the development of new alloys, new methods and new techniques for wiping solders is also not included in this paper because space does not permit. Further the problems involved in the handling, use and application of wiping solders are quite different from those involved in normal soldering operations but naturally some of the knowledge gleaned from some 500 tests in connection with the development of 18 experimental binary and ternary alloys is included in this paper.

The author wishes to acknowledge the many courtesies and advice extended to him by G. O. Hiers of the research laboratories of the National Lead Co. and particularly for his kindness in checking the information in this paper and for his constructive criticism. The author also wishes to acknowledge the assistance and advice rendered by members of the Western Union Laboratories and in particular B. L. Kline of the chemical research laboratory for chemical analyses and to Dr. Frances H. Clark of the metallographic research laboratory.

A CORRECTION: In the first part of this article, in our March issue, the chart of melting and freezing ranges on page 704 contains an inconspicuous but important draftsman's error, for which we apologize. The word "Solid" just above "for engineering purposes" should be changed to "Pasty."

—*The Editors.*

A Materials Article **Every engineer is heartily in favor of anything that leads to more specific specifications and should therefore welcome this discussion of the composition grades of low-carbon steel that are best suited for high-speed manual arc welding.**

Which Carbon Steel for Arc Welding?

by **W. J. CONLEY** *Consulting Engineer, Lincoln Electric Co., Cleveland*

By 1941 welding had advanced to the stage where it was firmly established as a manufacturing process. It was recognized that for the best results engineering methods had to be used to realize the full advantages of simplicity, flexibility, continuity and lower costs. There was a decided tendency to the use of higher arc speeds, larger electrodes and higher currents for manual arc welding.

This trend, along with the urgent demand for increased production with the entry of the United States into the war, caused more attention to be given to control and procedures. The lack of experienced welders and time to train operators led to wider use of down hand or flat position welding. This meant more efficient planning, better joint preparation and the use of handling equipment plus jigs and fixtures to insure better fit-up.

With the application of engineering thought to welding, more intensive study was given to design suited to this process. This resulted in specifying the type of joint, size of weld, size of electrode, current and arc speed. The demand for increased welding speeds necessitated the use of equipment of larger capacity so that it was finally possible to produce, manually, 100 percent welds on plate as thick as ⅜ in. by means of two passes, one from each side.

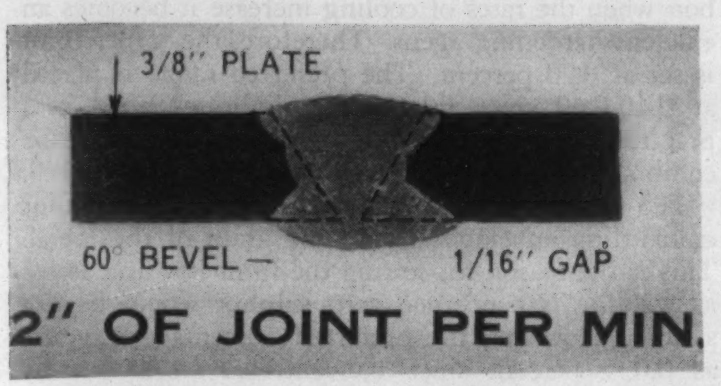


Fig. 1. Conventional method—relatively large amount of weld metal in joint.

Importance of the Base Metal

Figure 1 shows a 60° bevel joint with the approximate proportions of deposited metal to that fused as compared to that of Figure 2 showing the same for a square edge butt joint made with high arc speed and amperes. The same principles were applied to fillet welds, especially the type shown in Figure 3. Figure 4 shows the condition for the weld made under same procedure as for the butt. The joints in Figure 3 and Figure 4 have the same strength but it can be easily seen that a much larger amount of base metal has been fused in Fig. 4 made in one-half the time of that for Fig. 3.

Thus the base metal has become more important since more of it enters into the weld to affect the performance of the joint and the efficiency of the welding. If the parent metal does not have characteristics which make it possible to weld it with the greatest ease the welding time will go up and very materially affect costs. This does not mean that the steel is not weldable but that it costs more than it should to make the weld.

All steel can be joined by welding with the proper procedures entailing high cost which may be justified by the performance. However, for quantity production it will pay to specify the steel from the point of view of the greatest ease of welding. It is as easy to specify an S.A.E. or A.I.S.I. steel of a given number as it is to order "hot-rolled" or "low-carbon" stock. This phase has not been given the attention its importance deserves by designers so that in many instances material has been supplied to the shop which has greatly handicapped production through the necessity for special procedures because the steel had poor weldability. This would correspond to setting up close limits on feeds and speeds for machining a steel forging and neglecting the carbon content or the metallurgical condition of the metal.

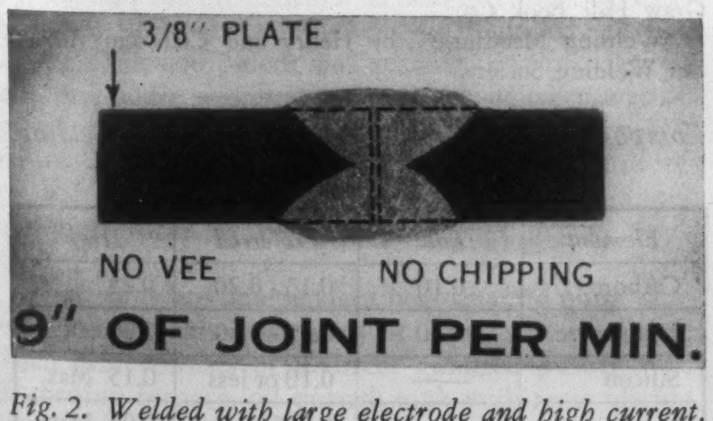


Fig. 2. Welded with large electrode and high current. Relatively large amount of base metal fused.

Composition Limits: Carbon

The Table gives the limits for the principal elements in steel to insure the best performance for manual arc welding. The weld metal is low in carbon, the strength being obtained through the action of deoxidizers and the refining action of the arc which produces a dense relatively high strength plastic material. It has sufficient capacity to absorb elements from the base metal through admixing in the case of bevel joints or where a relatively small amount of base metal is fused (low penetration) without reducing the plasticity to a dangerous point, for carbon content up to .30 percent and plate thickness under ½ inch (assuming that no special procedure, such as preheating or post-heating, is used). However, if other elements such as manganese, silicon, phosphorus and sulphur reach higher limits than those shown in the high column greater tendency for trouble will be encountered. This is particularly true for high arc speeds using larger amperage with large electrodes.

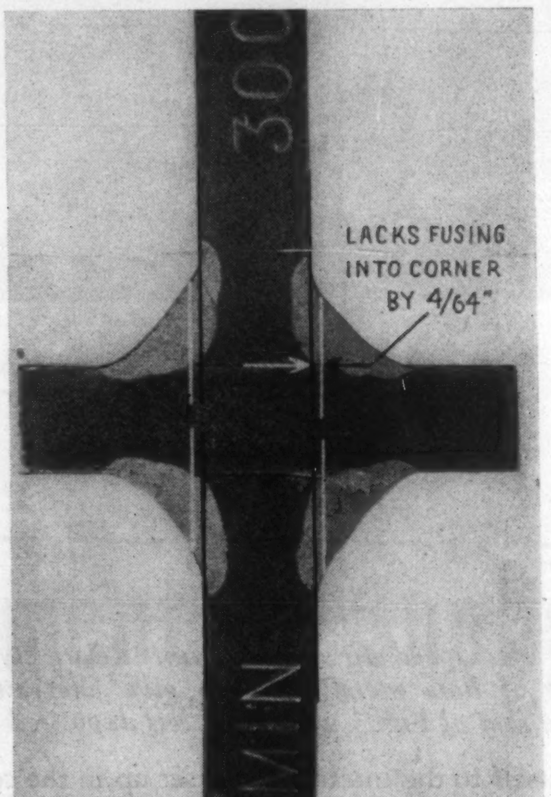


Fig. 3. Arc speed 6 in. per min. Strength developed by deposited metal.

The limits given in the table assume that steels falling in these ranges are satisfactory from the point of view of their mechanical properties. The values are set for practical reasons which will be briefly discussed assuming that the reader has a fundamental knowledge of some of the metallurgical principles. Carbon is the principal alloy used to give strength and hardness to steel in the unrolled condition. As the rate of cooling from temperatures above the critical is increased this element causes greater strength and hardness with a corresponding reduction in elongation and plasticity.

The rate of cooling in welding depends on several variables, such as thickness of metal being joined, temperature at start of and during welding and whether or not post-heating is used. The temperature during welding depends on current speed and type of joint. When these combine to give the highest cooling rates carbon and manganese contents larger than those given in the "high" column of the table may lower the plasticity and cause hardening in the heat-affected zone of the base metal. This may develop to such an extent that the metal may not be able to adjust itself to the internal stress set up in the cooling or may not have good performance under repeated and shock loading, and this unfortunate result may occur even though microscopic cracks do not form in the hardened zone.

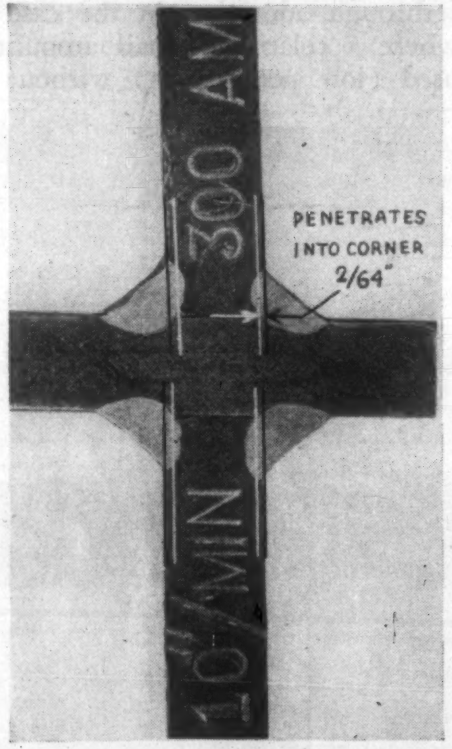


Fig. 4. Arc speed 10 in. per min. Relatively large amount of base metal fused to give fillet strength equal to that of Fig. 3 with 40% less deposited metal.

A lower limit is also set at 0.10% for carbon since if this content is less and less there is an increasing tendency for the metal to absorb gas while molten. These gases must escape as the solubility is lowered on solidification. Consequently sufficient time must be allowed during passage through the solidification range to allow gases to escape, or gas-escape must be permitted in some other manner. Then, too, iron oxide (FeO) will form to remain in solution in the solid metal to adversely affect the properties. This is the reason for the preferred range, since the amounts of carbon and manganese given widen the solidification temperature zone sufficiently to allow time for the escape of gas with the accompanying improvement in quality of metal.

Other Elements

Next to carbon, manganese is the most common element used to strengthen steel. Together with carbon when the rates of cooling increase it becomes an efficient hardening agent. Therefore, the upper limit is set at 0.90 percent. The preferred range is placed at 0.40-0.60 since this usually indicates good mill practice and is enough to cause all the sulphur to be combined as MnS and therefore does not produce FeS.

FeS is harmful since it forms a low melting point embrittling envelope around the grain of the metal. This is the reason for setting the limit low and as far as welding is concerned zero sulphur would be desirable. However, the preferred percentage is given as 0.035 percent since conventional steels can be ordered, without paying a premium, which contain this percentage with an upper limit of not more than 0.05.

Phosphorus could also be wholly absent but the range as given is indicated for the same reason as stated above for sulphur. In larger amounts it tends to produce shock embrittlement at low temperature and promotes weakness just below solidification while sulphur tends to make the steel hot short. In the case of thin gage sheet, high sulphur causes melting through, particularly when fit-up is not good.

Silicon is another element which could be absent but a small amount, not over 0.15, may aid in gas control since it widens the solidification range. Silicon reacts to pick up oxygen released as such or in CO when FeO and MnO are reduced by carbon. The SiO_2 either is caught in the solid metal as microscopic inclusions or enters the slag, the usual procedure. Thus silicon may be a safety guard especially for the higher manganese contents.

The following "Base Price" steels (steels for which there is no additional charge for analysis control) satisfy the range of the above elements given in the preferred column of Table 1 when silicon is specified at a maximum of 0.10 percent; AISI-C1014, C1015, C1017, C1020, C1021, C1023 and NE 1015, 1017, 1018, 1020 and SAE 1010, 1015 and 1020. The average properties of these steels are approximately 67,000 p.s.i. tensile strength and 32% elongation in 2 in. These analyses give steel having characteristics allowing the highest welding speeds with good bead appearance and sound weld metal and can be ordered just as easily as any other grade.

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Composition Limits of Steel for Efficient Welding, in per cent

Element	*Low*	*Preferred*	*High*
Carbon	0.10	0.13 - 0.20	0.25
Manganese	0.30	0.40 - 0.60	0,90
Silicon	——	0.10 or less	0.15 Max.
Sulphur	——	0.035 or less	0.05 Max.
Phosphorus	——	0.04 or less	0.04 Max.

A Methods Article The effect of surface preparation on the accuracy of spectrographic analyses is demonstrated by Mr. Waring and a useful machining practice and tool design for the purpose described.

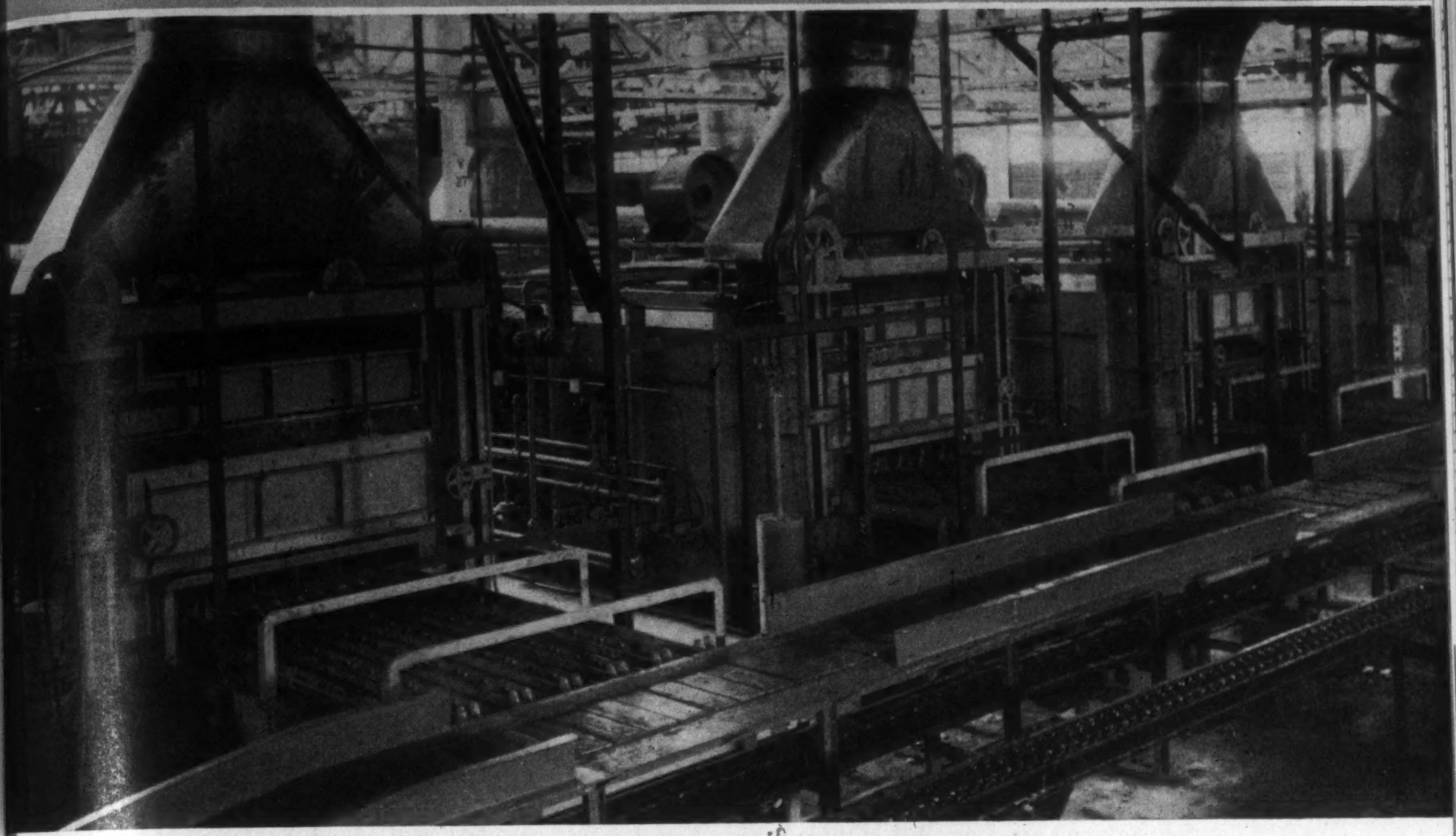


Fig. 1. A conveyor brings the shells to the charging end of the hardening furnaces.

Continuous Heat Treatment of Shells

by D. E. WYMAN

Chief Engineer, R-S Products Corp., Philadelphia

ONE OF THE OUTSTANDING installations in the country for the continuous heat treatment of 155-mm. high explosive shells is described in this article. This equipment was designed and installed in a large middle western plant. Quick delivery was of prime importance—other requirements were simplicity of design, rugged construction, conservation of critical materials, continuous dependable operation, and uniformity of physical properties in the heat-treated product.

Four complete independent heat-treating units were installed with total capacity of 250 shells per hour. Each unit consists of a direct gas-fired pusher type hardening furnace, oil quench tank with recirculating pumps and oil coolers, a hydraulic system for operating the hardening furnace pusher, shell tilter and quench tank conveyor, and a continuous convection type draw furnace.

After rough machining, the shells travel on continuous conveyors to induction-type nosing furnaces and are hot nosed in adjacent presses. They are then placed on a conveyor which brings them to the charging end of the hardening furnaces as shown by Fig. 1.

The Hardening Furnaces

The shells are manually pushed from this conveyor onto the charging platforms in front of the furnaces.

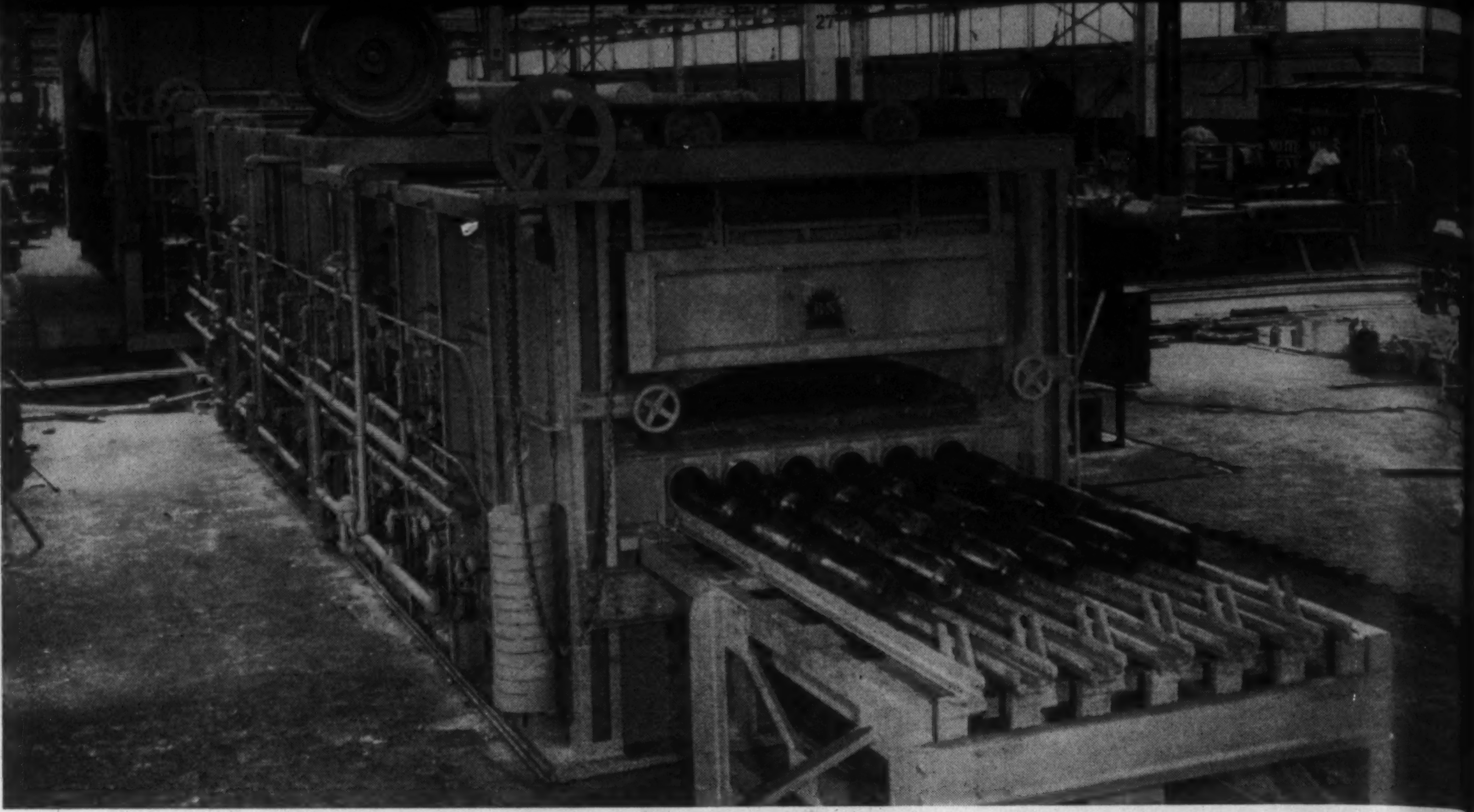


Fig. 2. The pusher dogs tilt forward allowing the shell to be moved forward.

The pusher dogs tilt forward allowing the shell to be moved forward sufficiently for the dogs to fall back into the pushing position, as shown by Fig. 2.

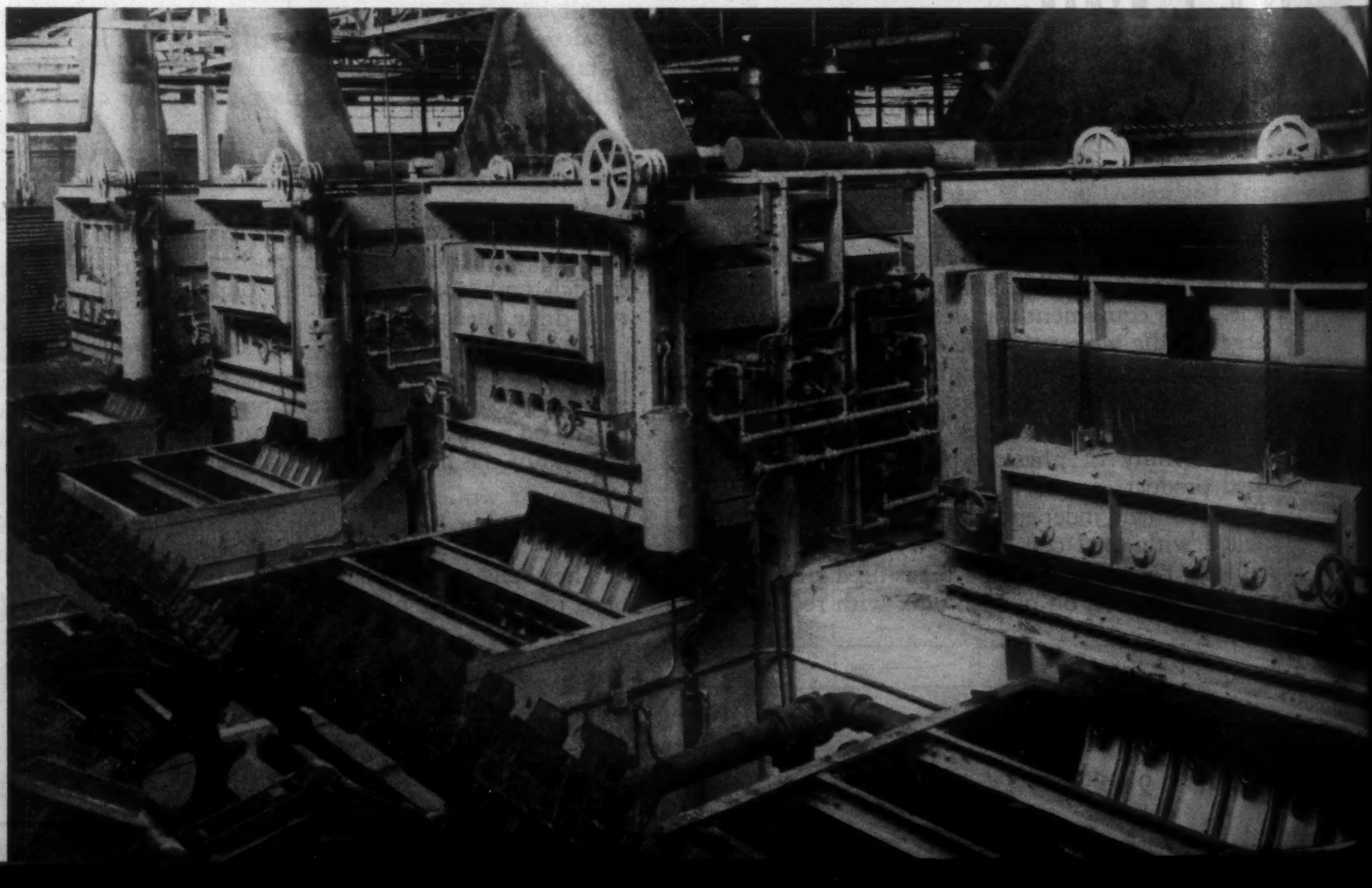
The hardening furnaces, which are direct gas-fired, are each equipped with 42 gas burners of the proportional mixing type. These burners are installed above and below the work and are controlled in three zones by L. & N. recording controllers and Automatic Temperature Control Co. motor operated valves. The furnaces are controlled at 1600 F and the shells remain in the furnace for 90 min.

The shells are pushed through centrifugally cast heat-resisting alloy tubes supported and held in line by cast alloy saddles. There are six rows of tubes in each furnace. As the products of combustion cannot come in contact with the shells, the amount of scale formed on the exterior and interior surfaces is very slight, making it quite easy to clean the shells after heat treatment.

The tubes terminate at the discharge end of the furnace and are sealed into alloy discharge tubes which are sealed in chutes which extend below the oil level in the quench tank and which direct the shells onto individual shell quench fixtures, as shown in Fig. 3.

Six shells are discharged simultaneously from the hardening furnace onto the quench fixtures and are quenched internally from central oil jets and externally from three spray pipes around each shell. The shells remain on the quench fixtures approximately 5 min. The hydraulically operated tilting mechanism, which is synchronized with the draw furnace conveyor, then tilts the shells into position for removal by shell carriers attached to the quench tank conveyor.

Fig. 3. Tubes terminate at the discharge end of the furnace and are sealed.



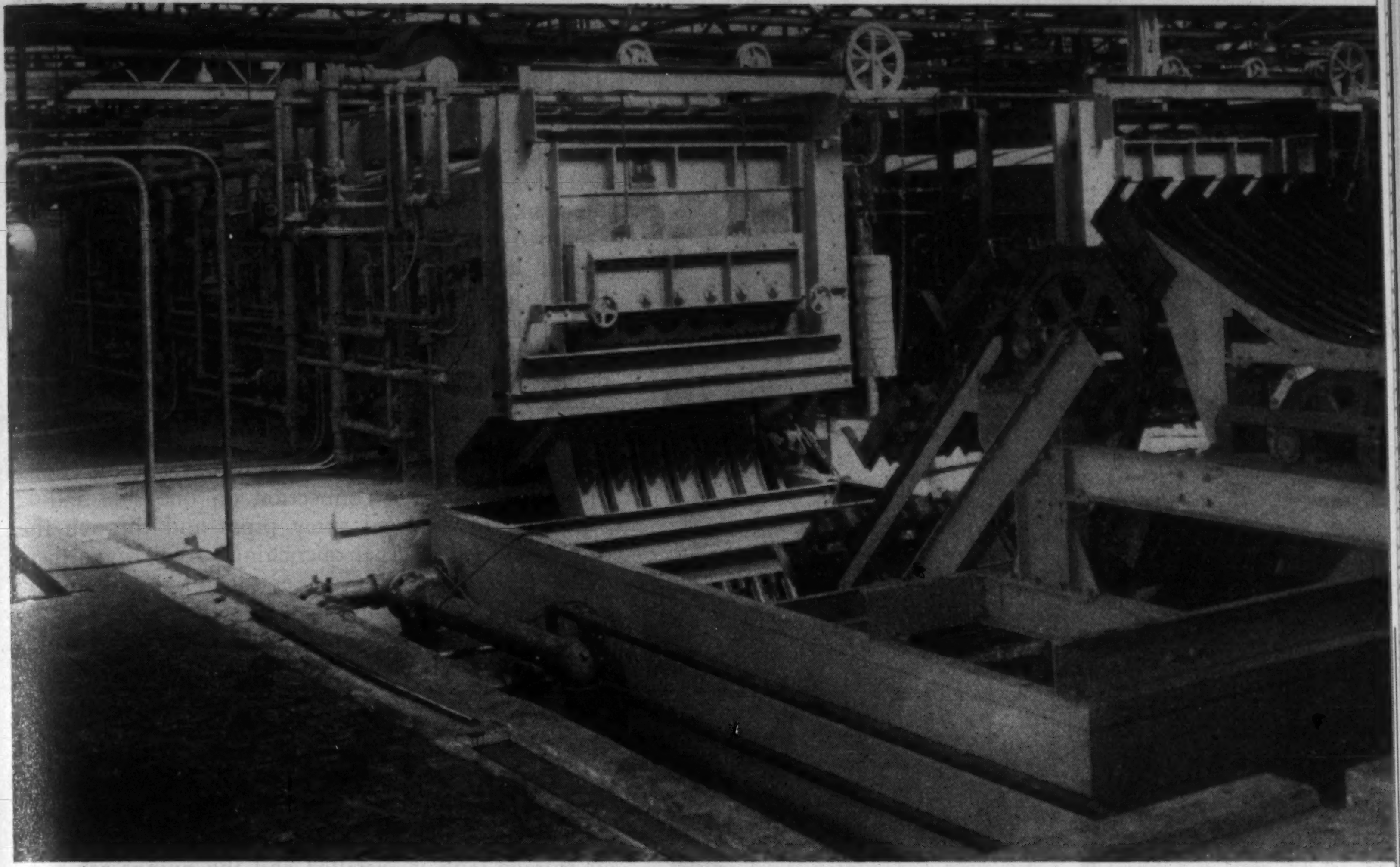
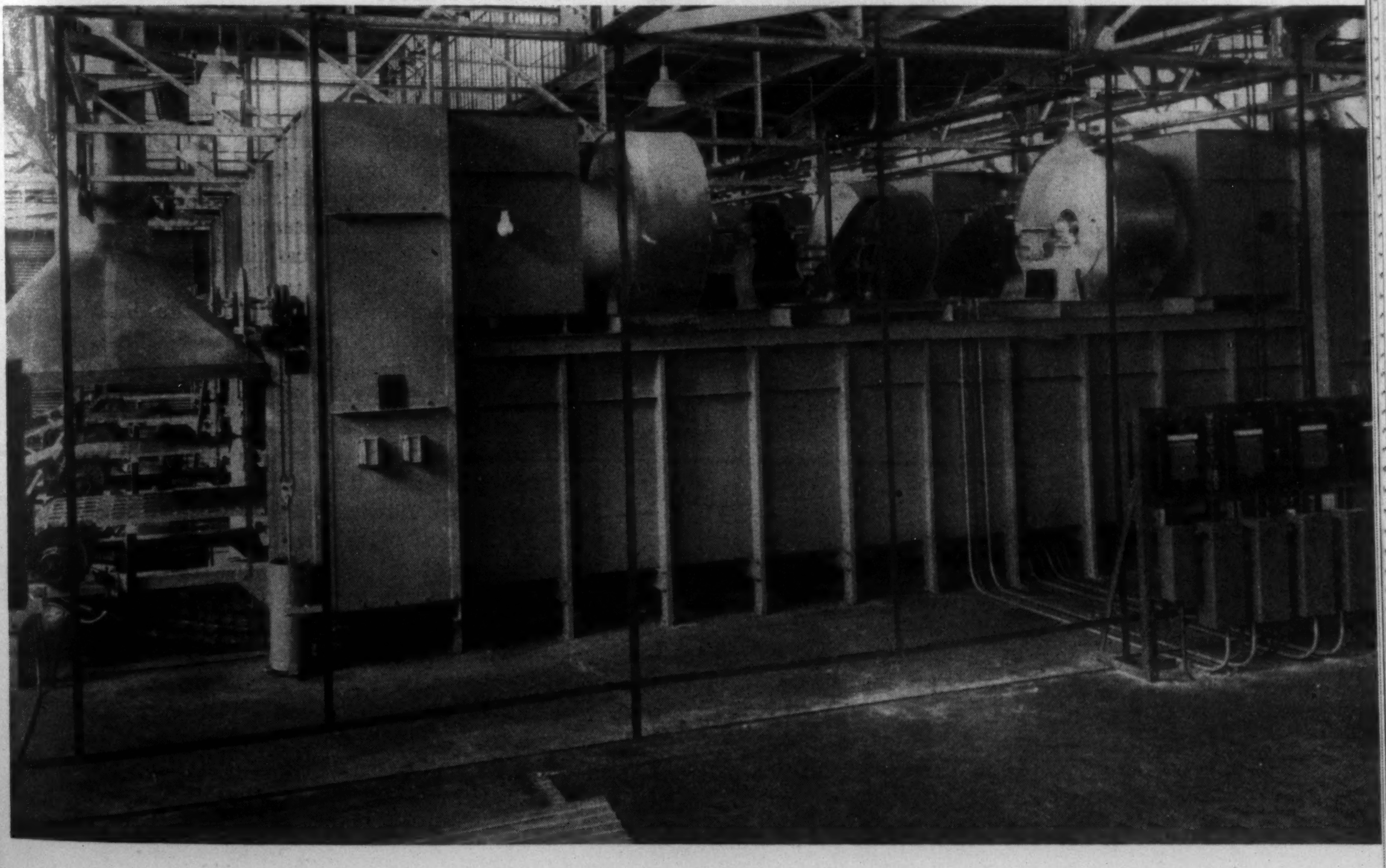


Fig. 4. All shells on the conveyor are advanced allowing six shells to be delivered onto the draw furnace conveyor.

Fig. 5. Two insulated, recirculating fans, each driven by a 20-h.p. motor are installed on each furnace.



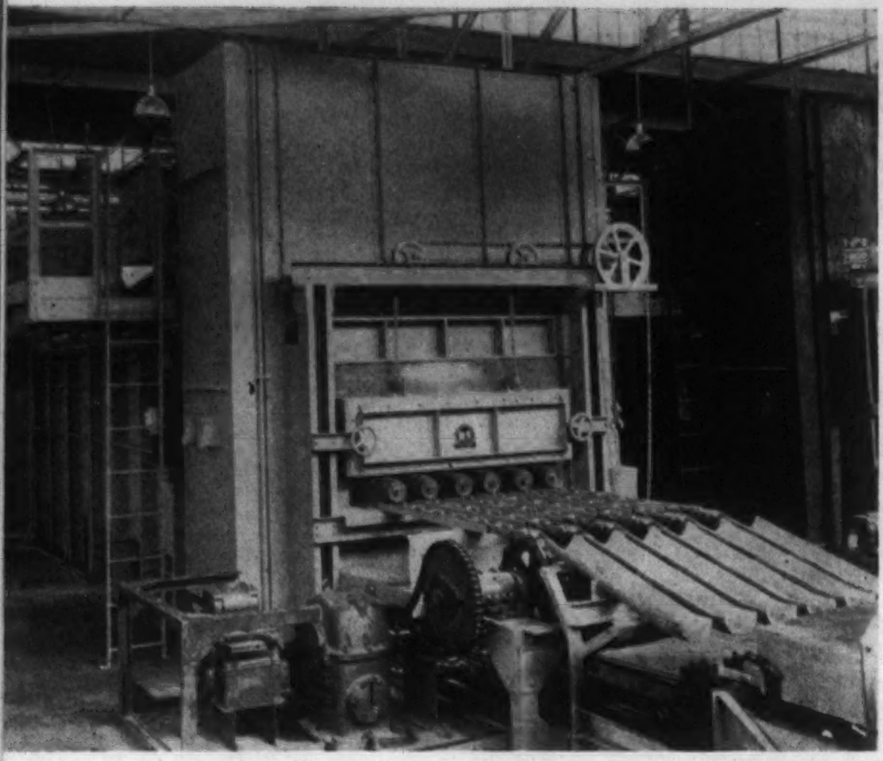


Fig. 6. The shells are conveyed through the draw furnace on six continuously moving chains.

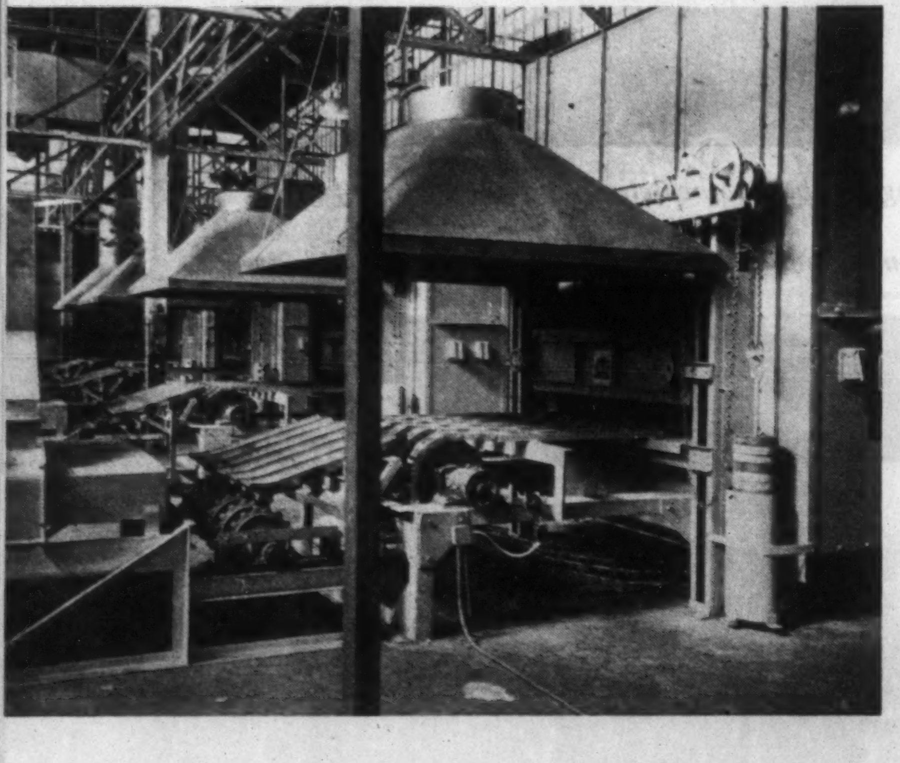


Fig. 7. After leaving the furnace, the shells are transferred to another conveyor traveling through a cooling chamber.

After the tilting mechanism comes to rest, the hydraulic mechanism which operates the conveyor, moves the conveyor one unit of length stripping the shell from the quench fixtures. At the same time all shells on the conveyor are advanced allowing six shells to be delivered onto the draw furnace conveyor (see Fig. 4).

After the quench conveyor has stopped, the tilter moves back to its original position and the hydraulic cylinder on the hardening furnace pushes six shells into the furnace and discharges six others onto the quench fixture.

The Oil-Handling System

The shells which have just been placed on the quench conveyor remain submerged below the oil level for another five minutes before emerging from the tank for draining. The shells are removed with the open end down and remain on the conveyor above the oil level approximately 15 min., allowing ample time to drain before being automatically discharged down inclined skids onto the draw furnace conveyor.

The quenching oil is circulated by two centrifugal pumps each having a capacity of 400 gpm. The oil passes through large basket type strainers before entering the pumps and is forced through horizontal shell and tube type heat exchangers. The oil enters the tank through a connection on one side and is piped to the external spray pipes and through the tilter shaft for internal quenching. A dial-type thermometer indicates the temperature of the oil in the tank which is normally held at 130 F. The flow of water through the coolers is controlled by a thermostatic bellows type valve. The capacity of each quench tank is approximately 11,000 gal.

The quench oil circulating pumps and coolers as well as the hydraulic pump unit are mounted beside each quench tank. All tanks are installed in a common pit so that equipment on the four units can be serviced with the utmost convenience. An auxiliary oil storage tank is installed and the pumps are connected so that any quench tank may be quickly emptied for periodic cleaning.

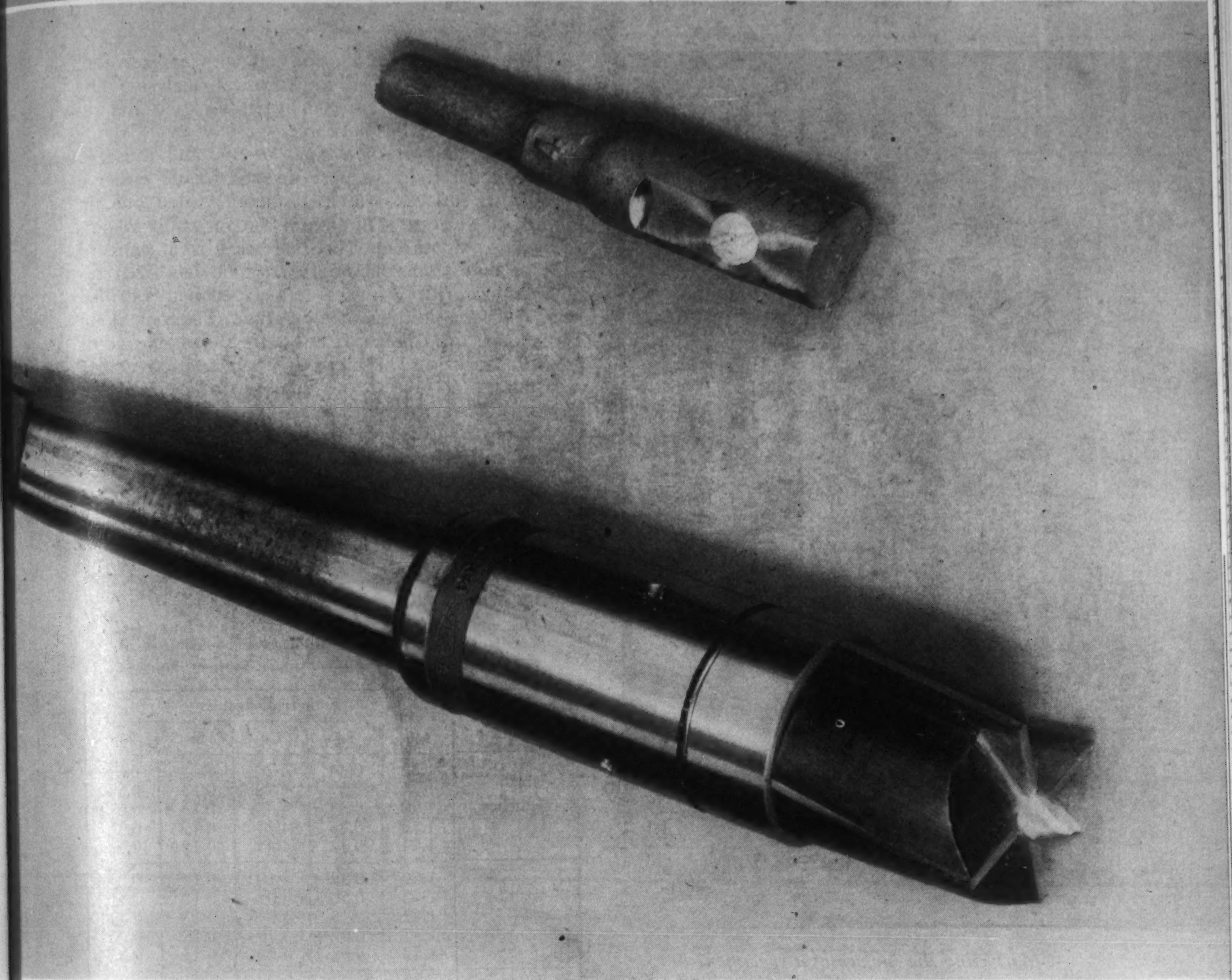
The Draw Furnaces

The draw furnaces, which are of the convection type, are gas-fired and equipped with complete flame safety equipment. These furnaces are suitable for a maximum operating temperature of 1400 F, although the usual operating temperature is 1200 F. Two insulated recirculating fans each driven by a 20-h.p. motor are installed on each furnace, as shown in Fig. 5. The furnace temperature is controlled by two L. & N. recording controllers and motor-operated control valves.

The shells are conveyed through the draw furnace on six continuously moving chains which are designed to keep the shells in proper alignment (see Fig. 6). The conveyor is driven by a variable speed drive unit which is set so that the shells remain in the furnace 105 min. To change the timing throughout the entire unit it is only necessary to turn the speed change handwheel on the variable speed drive, as the operation of the hydraulic drive is controlled by the travel of the draw furnace conveyor.

After leaving the furnace, the shells are transferred to another conveyor traveling through a cooling chamber in which they are cooled for subsequent operations as shown by Fig. 7. Each furnace is equipped with an independent blower which supplies air for the gas burners. Each furnace is also equipped with a safety shut-off valve which will close in case of air, gas or power failure.

A Methods Article The interesting practice and modern equipment used by one manufacturer for shell hardening and tempering are described in this brief, well-illustrated article.



Combination spot-facing and drilling tool used to prepare spectrographic samples and a specimen prepared by it.

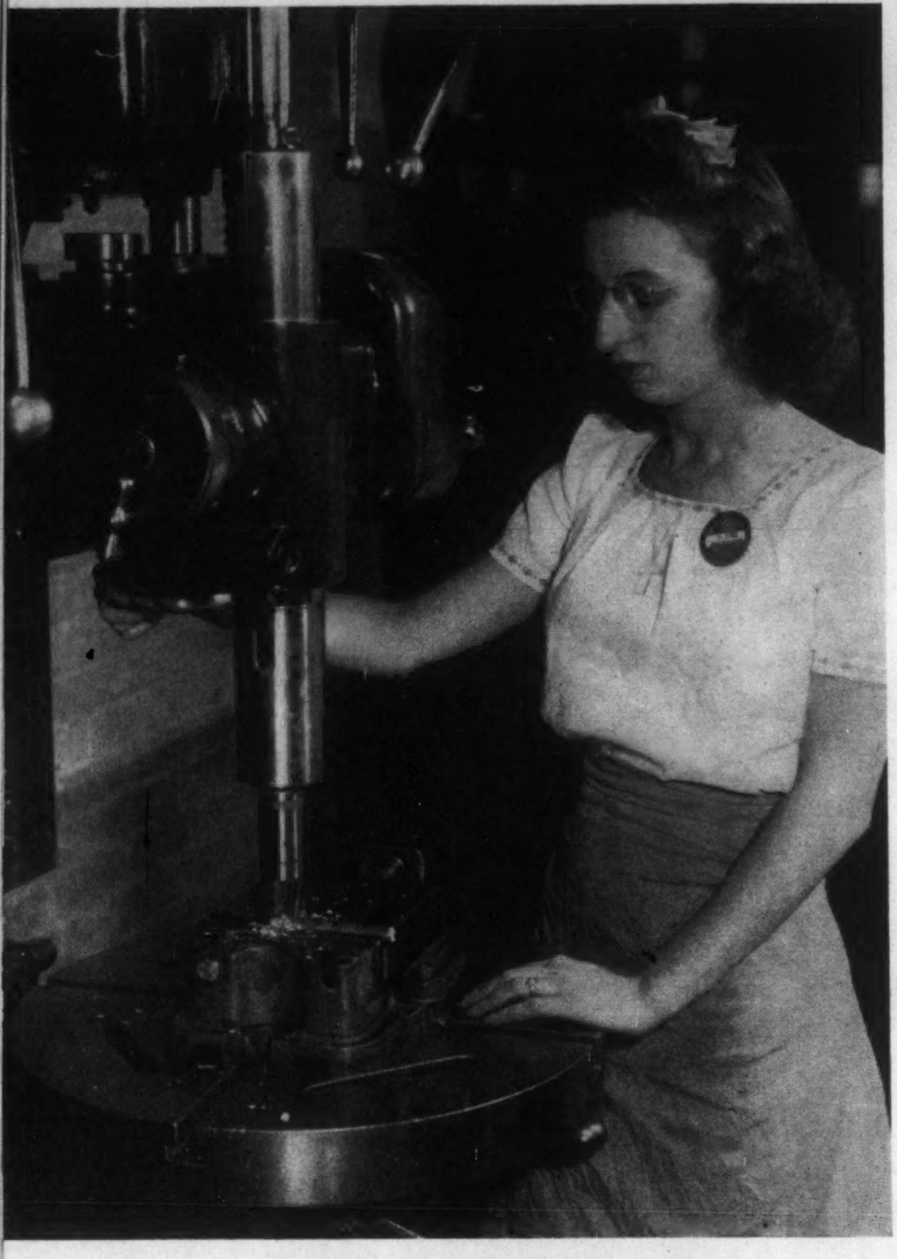
Machining Spectrographic Samples

by C. L. WARING

Chief Spectrographer
The Glenn L. Martin Co., Baltimore, Md.

THE SPECTROGRAPH has been employed in the Laboratory of the Glenn L. Martin Co. for the past two years, as a rapid means of checking the quantitative chemical analysis of the materials used in the manufacture of aircraft. At present, approximately 95% of the aluminum alloys, 100% of the magnesium alloys, and 10% of the steels are being tested by this method.

A grating spectrograph is used. All specimens are considered as massive electrodes, when mounted on a Petrey spark stand and excited with A.C. spark. The lower electrode is a spectrographic carbon rod ¼-in. in diameter, sharpened to a 2 mm. flat circular tip. A pre-spark period of 10 sec. is used for all specimens. Actual photographic exposure for aluminum alloy and steel is 15 sec., while 20 sec. exposure is used for magnesium alloys. Eastman spectrum analysis plates, No. 1, are used.



Machining the surface of a specimen.

Since the material received for analysis has various sizes, shapes, and thicknesses, sample preparation is an important item. Extrusions, bars, castings, tubes, forgings, sheet and even rivets, must be prepared for spectrographic analysis. When the size of the specimen permits, a section approximately 1-in. sq. is cut, and spot faced, to give the desired smooth, flat surface. The spark covers a ¼-in. diam. area of the surface, and any undersize specimen, such as small rivets and screws, is pressed into a briquette of the proper size. Standards representing these various specimens have been purchased or standardized in our chemical laboratory.

The proper surface preparation of specimens for spectrographic analysis has caused some concern in our laboratory. An investigation of the effect of various surfaces upon the final determination was conducted.

A length of 24ST aluminum alloy bar was cut into eight sections, and the surfaces prepared for spectrographic analysis as follows: (1) Vixen file—surface containing scratches; (2) Band saw; (3) Abrasive saw cut; (4) Belt sander; (5) Surface filed smooth but not flat with a vixen file; (6) Spot-faced surface; (7) Surface filed smooth and flat with a vixen file; and (8) Section milled for chemical analysis. The test specimens were sparked five times each and results are recorded in the Table.

On the basis of these final results, and those of many similar tests, we have decided to use either a spot-faced surface, or a flat, smoothly filed one, in order to reduce to a minimum the variation in percentage composition. The tool used is a standard 1½-in. spot-facer, the pilot of which has been replaced by a drill. With this tool a specimen is drilled and spot-faced in the same operation. The tool, along with a specimen prepared by it, are shown in one of the illustrations. The method of preparation is also illustrated. To give a clean, smooth surface, kerosene is used as a lubricant. The tool is cleaned of chips after preparing each specimen.

Surfaces prepared in this manner give final answers which check closely with chemical analysis. A metallic cut is necessary, since abrasive cuts show evidence of contamination. The surface or base of any specimen should be flat, so as to hold the three millimeter spark gap constant, otherwise a variation of relative intensity will result.

Results of Spectrographic Analysis of Specimens of 24ST Aluminum Bar with Various Surface Finishes

Surface Treatment	Analytical Results				
	Mg	Fe	Cu	Si	Mn
1—Filed (scratches)	1.32	0.34	4.20	0.17	0.61
	1.51	0.37	4.10	0.13	0.63
	1.50	0.33	4.40	0.14	0.61
	1.58	0.48	4.25	0.19	0.56
	1.54	0.32	4.45	0.12	0.52
2—Band saw	1.50	0.38	4.10	0.17	0.57
	1.42	0.50	4.05	0.12	0.51
	1.42	0.35	3.95	0.13	0.51
	1.32	0.27	4.20	0.19	0.46
	1.44	0.38	4.00	0.11	0.52
3—Abrasive saw	1.42	0.27	4.30	0.20	0.68
	1.50	0.43	4.10	0.13	0.71
	1.50	0.34	4.50	0.19	0.77
	1.52	0.43	4.55	0.23	0.76
	1.40	0.42	4.40	0.20	0.82
4—Belt sander	1.42	0.39	4.40	0.23	0.72
	1.50	0.48	4.45	0.15	0.67
	1.42	0.31	4.35	0.28	0.53
	1.40	0.35	4.40	0.15	0.67
	1.50	0.26	4.45	0.20	0.50
5—Smooth filed surface (Not Flat)	1.46	0.35	4.45	0.16	0.65
	1.40	0.30	4.05	0.11	0.52
	1.58	0.33	4.50	0.15	0.62
	1.53	0.28	4.50	0.13	0.60
	1.50	0.35	4.35	0.10	0.53
6—Spot-faced	1.48	0.34	4.20	0.15	0.62
	1.47	0.32	4.25	0.13	0.64
	1.50	0.33	4.25	0.16	0.64
	1.50	0.33	4.26	0.15	0.62
	1.50	0.31	4.22	0.14	0.61
7—Smooth flat surface filed	1.48	0.34	4.23	0.16	0.62
	1.47	0.32	4.20	0.14	0.61
	1.51	0.35	4.25	0.15	0.62
	1.48	0.34	4.20	0.14	0.59
	1.51	0.33	4.28	0.13	0.59
8—Chemical analysis	**1.48**	**0.36**	**4.20**	**0.15**	**—**

MATERIALS & METHODS MANUAL

5

This is another in a series of Manuals on engineering materials and production methods, published at periodic intervals as special sections in Metals and Alloys. Each of them is intended to be a compressed handbook on its particular subject and to be packed with useful reference data on the characteristics of certain materials or metal-forms or with essential principles, best procedures and operating data for performing specific metal-working processes.

Permanent Mold Castings

by Alfred Sugar

American Metal Co., Ltd., New York

Many aircraft parts and other military products made as permanent mold castings during the war have demonstrated the possibilities in saving materials, machine time and money, and in improving mechanical quality offered by this process. In this Manual Mr. Sugar reviews the application advantages and design principles for permanent mold castings as well as the materials that can be used, and presents a large amount of instructive and heretofore unpublished information on their manufacture. The material is of major interest therefore to both design and production engineers planning their war and post-war products.

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Metals and Alloys, April 1945

Introduction

PERMANENT MOLD castings may be defined as those produced in hand- or mechanically operated metal molds without the application of external pressure. The name "permanent mold casting" is something of a misnomer. Although the life of a permanent mold is long and a single unit may be used repeatedly, its life can hardly be called permanent. Perhaps the British designation of "gravity die casting," stressing the use of no external pressure, may be a more fitting name for the process.

Long before the art of making castings in sand became established metal castings were made in "long lived" molds. Ancient tools and weapons were cast in stone until the time when casting in sand developed into procedure more convenient for people lacking means of producing more accurate impressions in either stone or metal. The art of permanent mold casting lay dormant until the arrival of the era of mass production, when the marked advantages and economies of a method capable of producing a great many identical castings from a single impression were recognized.

With machine tools furnishing a not too laborious or expensive method of converting rough castings, forgings and bar stock into the finished, closely fitted segments which go to make up a permanent mold, another obstacle was removed from the path of the commercial adoption of this process. Costs per unit casting, cost of equipment per unit casting, foundry space required, the rate of production per unit, machining time and costs, all favor the adoption of the permanent mold process where volume production is concerned. As a general rule 500 castings may be considered as the minimum number for which a permanent mold may be economically built.

Some commercial permanent mold castings are made of iron, zinc and bronze or brass, but by far the largest tonnage produced is in the light metals, especially aluminum. Most aluminum castings made in sand can be advantageously adapted to the permanent mold process. Some exceptions are: Castings so complicated in shape that mold sections cannot be readily pulled away once the casting has been poured, very large castings, where the mold cost would be prohibitive, and very small castings where many more impressions can be put on a single pattern than would be considered feasible for a permanent mold unit.

When recesses in a casting are so complex that metal cores are not readily removable, sand cores are employed, and this is often called semi-permanent-mold casting. In semi-permanent molding, sand cores are made up for each individual casting as is the case in sand casting, otherwise the method is identical to full permanent molding. When cores can be readily withdrawn from the recesses they form, one-piece cores of close-grained cast iron or multiple piece collapsible cores of fully hardened alloy steel are employed for both the permanent mold and semi-permanent mold processes.

Originally used only for medium sized castings, the permanent mold art has now advanced to a stage where castings up to 36 inches in length and weighing 55 pounds are commonplace.

Application and Design Features

Although permanent mold castings are chiefly regarded as in competition with or as replacements for sand castings, they often merit consideration along with die castings, plaster mold castings, forgings, etc. when the fabrication-type or production method for a particular part is being selected. In general the field for permanent mold castings lies somewhere between those for sand castings and die castings. It is, indeed, between those two forms with respect to the permissible intricacy of design, closeness with which tolerances can be held, mold or die costs, direct labor charges and possible production speeds.

Competitive Advantages and Disadvantages

As with all metal-mold or metal-die fabricating methods the unit cost of a particular part decreases as the production requirements increase; thus in a cost comparison between permanent mold castings and sand castings, the advantage that the usually lower pattern cost for sand castings has over the mold cost for permanent mold castings becomes less and less and may even be reversed as the lot sizes go higher and higher.

Some of the advantages of permanent mold castings over sand castings may be listed as follows:

(a) More castings can be produced per unit time per unit of equipment.

(b) Permanent mold castings have a more pleasing surface.

(c) A finer grain size and improvements in response to heat treatment and in physical properties due to more rapid solidification in an iron mold are obtained.

(d) Permanent mold castings can be made within limits of 0.010 in., much closer dimensions than are possible in a sand casting—thus effecting a saving in metal, in machining time and in machining cost. For example—a sand casting weighing 66 lb. in the rough had 16 lb. of metal removed to bring it to finished size; the same casting when made in a permanent mold weighed 56 lb. in the rough and also finished at 50 lb.—a saving of 10 lb. of aluminum melted, cast and machined off to produce a finished part.

A description of several parts formerly made by sand casting and converted to permanent mold castings, recently published by Fahlman and Chase,[1] includes many interesting application examples. Typical of what can be done today is a combination flywheel-and-fan casting measuring 34 in. in diameter and 6 in. high and weighing 55 lb. Other permanent mold castings whose production has been substantial include oil filter motor housings, governor cases for variable pitch propellers, pump housings, carburetor bodies, supercharger housings and (pre-war) washing-machine agitators.

These authors report a survey indicating that aircraft producers are making considerable use of permanent mold castings to replace sand castings in fuselage parts and other frame elements. The frame castings do not require such close tolerances as do engine parts—e.g. tolerances of 0.010 in. or 1/64 in. can be held in permanent mold castings and obviate most or all of the machining that would be required on the same parts if sand cast. Some airplane manufacturers even pay a sizable premium for the permanent mold castings and still realize a net saving in finished cost over that for the machined sand castings.

General comparisons of the two forms have been made by Chase.[2] The lower cost of molds as against dies sometimes favors the permanent mold casting, especially on small or medium-lot quantities, but on very-large-production quantities the advantages of die casting may predominate. Thus mold cost, original cost of equipment, soundness and maximum possible size tend to favor permanent mold castings; production rates, dimensional accuracy, surface smoothness, finishing costs, section thinness, permissible design complexity, and minimum size are usually better for die castings.

Often a choice must be made between permanent mold castings and plaster mold castings. In general the former type is favored for large-lot production and plaster mold castings for shorter-run jobs, since the mold costs (including pattern costs for the plaster mold) are higher for permanent mold castings, while labor costs may be lower. Plaster mold castings can usually be produced in more intricate shapes and with better reproduction of surface detail, while permanent mold castings have the advantage in the variety of materials available.

Occasionally competition develops between die-forgings and permanent mold castings, one replacement of a forging mentioned by Fahlman and Chase being a small motor housing. Forging dies cost more than permanent molds and tolerances cannot be so closely held, but forgings are characteristically stronger than castings of any type and can be made to larger sizes than can permanent mold castings. Hence the latter would be favored over forgings only for relatively small parts that had to be made to closer tolerances than die-forging could produce, and generally where production requirements are relatively small.

More detailed and specific comparisons of permanent mold castings with other types of parts have been made by Basch,[3] Young,[4]

Table I—Relative Design Characteristics of Different Casting Methods, According to Chase[5]. (Numbered in order of preference, No. 1 being the most desirable.)

Characteristic		Sand Castings	Plaster of Paris Mold Castings	Centrifugal Castings	Permanent-mold Castings	Gooseneck Die Castings	Cold Chamber, Pressure and Plunger Die Castings	Remarks
Porosity		6	2-1	1-2[a]	3-4[b]	4-5	4-3	[a] Ratings pertain to metal left after removal of drossy material from inside wall. [b] Ratings pertain to material next to metal mold in case of semi-permanent molds. [c] May be 1 for copper-base castings. [d] Inferior in strength to sand castings in aluminum alloys but possibly superior to sand castings in copper base alloys.
Surface smoothness		6	3-4[c]	5-4[a]	3-4[b]	2-3	1	
Sharpness of outline		6	3	4-5[a]	5-4[b]	2	1	
Strength (solid metal)		5-6	6-5[d]	3[a]	4[b]	2-1	1-2	
Thinness of section		5	3[c]	6	4	2	1	
Cost of tools, patterns, dies or molds		1	2-3	3-2	4	5-6	6-5	Tool cost and cost per casting depend on number of patterns per plate or impressions in die; the more castings can be made at one operation, the lower the labor cost per piece, with inversely increasing tool cost. Sand and plaster of paris patterns lend themselves more economically to multi-impressions than metal molds. The labor costs considered here include those for making the pattern, match-plate, metal mold or die. The ratings are on the basis of the most economical tool set-up (as to number of impressions on one pattern plate or in one die) for comparative production quantities.
Speed of production		4	5	5	3	2-1	1-2	
Labor Cost per Casting (as cast)	for small production	1	2	4	3	5-6	5-6	
	for large production	5	6	4	3	2-1	1-2	
Possibility to Save Machining		6-5[dd]	4	5-6[dd]	3	2-1	1-2	[dd] May be reversed in certain cases.

Chase[5] and Peters.[6]

Table I (from Chase's article[5]) gives a rating of the various metal-casting processes with respect to the chief selection factors of interest to design and production engineers. (It should be pointed out that Basch[3] and Young[4] have presented data that are not exactly in agreement with this Table, but the differences are chiefly in their appraisal of plaster mold castings and are only slight with respect to permanent mold castings.) This Table may serve as a guide in generally appraising the position of permanent mold castings as against the other types of parts.

Design Principles

Every metal-form has its own peculiar and characteristic set of design principles that should be followed for best results. Some of the more important of these have been briefly set forth by Swoboda[7] and several are discussed in detail in the mold-design sections of this Manual. Sometimes minor changes in design are enough to produce greater production or to permit the use of a permanent rather than a semi-permanent mold.

Provision must be made in the casting design for withdrawal of the cores and for the removal of the casting from the mold. Where the design cannot be changed to permit the use of a solid core, split cores, multiple-piece molds or sand cores must be used. Production is also expedited by providing a minimum number of cores, to cut down handling time, and long thin cores should be avoided to keep maintenance costs at a minimum.

Swoboda also offers some practical hints on casting geometry for the designer, the most important of which are summarized in Fig. 6. Some of his more detailed suggestions follow:

The marking of jigging points on the blueprint will aid the mold designer in placing parting lines, gates, and risers. In addition, the designer should know the exact position of the buyer's locating points so that both the supplier and buyer will check the accuracy of the casting from the same spots.

It is sometimes found desirable to cast inserts of other metals in light metal permanent mold castings. Since the light metal alloys have different coefficients of expansion from other metals, a definite foundry technique is required for the economical and proper use of inserts.

Wherever practicable, uniform sections should be maintained throughout a permanent mold casting. Section uniformity helps not only to simplify the gating and feeding problem, but also to equalize the rate of solidification, a very important factor in controlling the quality of permanent mold castings. With any kind of cast product, when sections vary in thickness, there is a tendency to set up internal strains in the casting and cause non-uniform solidification, which may lead to shrinkage and cracking. Therefore, in a design where light and heavy sections join, a gradual increase in thickness of the thinner section toward the point of junction will help considerably. In service, this blending assists in distributing loads over a larger area of the casting and thereby frequently eliminates undesirable stress concentrations.

The minimum section thickness possible in light metal permanent mold castings depends very materially on the size, pressure requirements, and intricacy of the casting. In general, however, the minimum section thickness which can be cast in permanent molds is approximately 1/8 in. When extremely thin sections are required, however, it may be necessary to make an engineering compromise, since it is necessary to sacrifice smoothness of surface to attain the desired thinness.

The designer should provide generous fillets at all wall intersections in a permanent mold casting to help prevent shrinkage

Table II—Commercial Tolerances (for guidance only) of Permanent Mold Castings Made in Different Materials. From Chase[5].

Metal	*Dimensional Tolerances Commonly Possible Within Mold*	*Minimum Wall Thickness in Inches (See Note)*	*Minimum Cored Hole Diameter and Maximum Length in Relation to Diameter*		*Minimum Draft per Side Per Inch of Depth of Side Wall or Holes, Inches per Inch*
			Diameter	*Max. Depth In Relation to Diam.*	
Magnesium Alloys	±0.0015 in. per inch, but at least ±0.010 in.	0.1875 (regardless of whether surface is rough or smooth)	Smaller than ¼ ¼ to ½ ½ to 1	Generally not cored 3 times 3-6 times	0.015
Aluminum Alloys	±0.0015 in. per inch, but at least ±0.010 in.	0.125 (0.090) where at least one side can be made reasonably rough	Smaller than ¼ ¼ ¼ to 1	Generally not cored 3 times 3-6 times	0.015
Bronze	±0.005 in. per inch, but at least ±0.010 in.	0.075 for small area. More for larger castings	Smaller than ¼ ¼ to ½ ½ to 1	Generally not cored 2 times 2-4 times	0.020
Remarks	Tolerances should be as liberal as possible in the interest of low mold and casting cost, where it is not necessary to have same to the limits given above. Closer limits than those given in table can be had, but usually only at higher die costs. Tolerances affected by moving members must be somewhat greater (across parting lines, etc.)	Varying with alloys (aluminum-silicon alloys, for instance, will cast in thinner sections than aluminum-copper alloys)	Cores for casting holes produce a beneficial chilling effect. Therefore, where possible, all holes should be cored, except when so small or deep that cores may be warped or bent under the shrinkage stresses of the freezing metal, or when drilling or punching is less expensive. Cores also save metal and machine work and also help to keep sections more nearly uniform in thickness.		Draft per side on walls where metal shrinks away from mold can be somewhat smaller. Liberal draft results in superior surface finish and facilitates removal of casting from mold.

Note: The minimum wall section which can be cast with different alloys is not absolutely fixed. It depends on the size and design of the casting, location of the section with reference to heavier adjacent sections, on the mold, the alloy, etc. In general, the lower the melting point and the more fluid the metal, and the shorter the distance the metal must flow between the chilling walls of the mold, or the *faster the metal traverses the distance,* the thinner the wall may be. There is practically no limitation on maximum wall thickness.

and cracking at these points. Sharp internal corners constitute a source of weakness in castings and should be avoided.

The use of multiple-piece and dry sand cores broadens the scope of the permanent-mold process and makes possible the production of some castings that could not otherwise be made by this method. If the "undercut" which necessitates multiple-piece cores can be eliminated, however, a saving in cost will result.

The amount of machine finish allowance necessary for permanent mold castings will usually be less than that for sand castings. Naturally, larger castings will require more allowance than smaller ones.

As mentioned earlier, permanent mold castings have greater dimensional accuracy than sand castings but cannot be held to tolerances which are as close as those possible by die casting. It is possible, however, to hold certain dimensions—either linear or thickness dimensions—within close limits. In such cases, the closer tolerances may be reflected in the increased cost of the product or in the lower production rate of the mold. From the standpoint of economy, the designer should not specify tolerances closer than are absolutely necessary.

The tolerances shown in Fig. 6 are considered good commercial practice but the design details of a casting often have a greater effect on tolerances than do size and weight. Chase[5] has published a detailed set of tolerances for various types of metal-mold castings, and his data on permanent mold castings are given in Table II.

A number of detailed design principles and typical design situations, based on European practice have been presented in a recent article by Vath,[6] and are worthy of careful study.

Materials Used

As mentioned earlier, aluminum, magnesium and zinc alloys, bronzes and iron are made into (statically cast) permanent mold castings, the aluminum alloys being the most widely used.

Among the more popular aluminum alloys for this purposes are the following:

(1) The common No. 12 alloy containing about 7% copper up to 4% silicon and about 2% zinc. This alloy has good casting characteristics, excellent machinability but does not respond to heat treatment. It was a very popular pre-war alloy and was used for making a great many consumer goods castings such as vacuum cleaner parts, washing machine agitators, waffle grids, etc.

(2) An alloy containing basically 5% silicon. This alloy has excellent casting characteristics, fair machinability and also does not respond to heat treatment. It is used for general casting containing thin sections and for cast cooking utensils.

(3 A 4.5% copper, 2.5% silicon alloy which has good foundry properties and good machinability and responds to heat treatment. It is at present a very popular casting alloy used wherever high strength and high ductility are required.

(4) A 1.5% copper, 5% silicon and 0.3% magnesium alloy which has excellent foundry properties, good machinability and responds to heat treatment. The alloy is used wherever high strength, leak proof castings are required.

(5) A 7% silicon, 0.3% magnesium alloy which has excellent casting characteristics, good machinability and responds to heat treatment. The alloy is generally used wherever high strength and corrosion resistance are of prime importance.

There are at present two magnesium alloys used for making permanent mold engineering castings. They are an alloy containing 9% aluminum and 2% zinc and a second alloy containing 10% aluminum. The second of the two alloys has the better foundry characteristics and the first the better physical characteristics. Both alloys respond to heat treatment.

Choice of the alloy for any specific part should be made on the basis of casting intricacy, foundry characteristics of the alloy, physical properties desired in finished part.

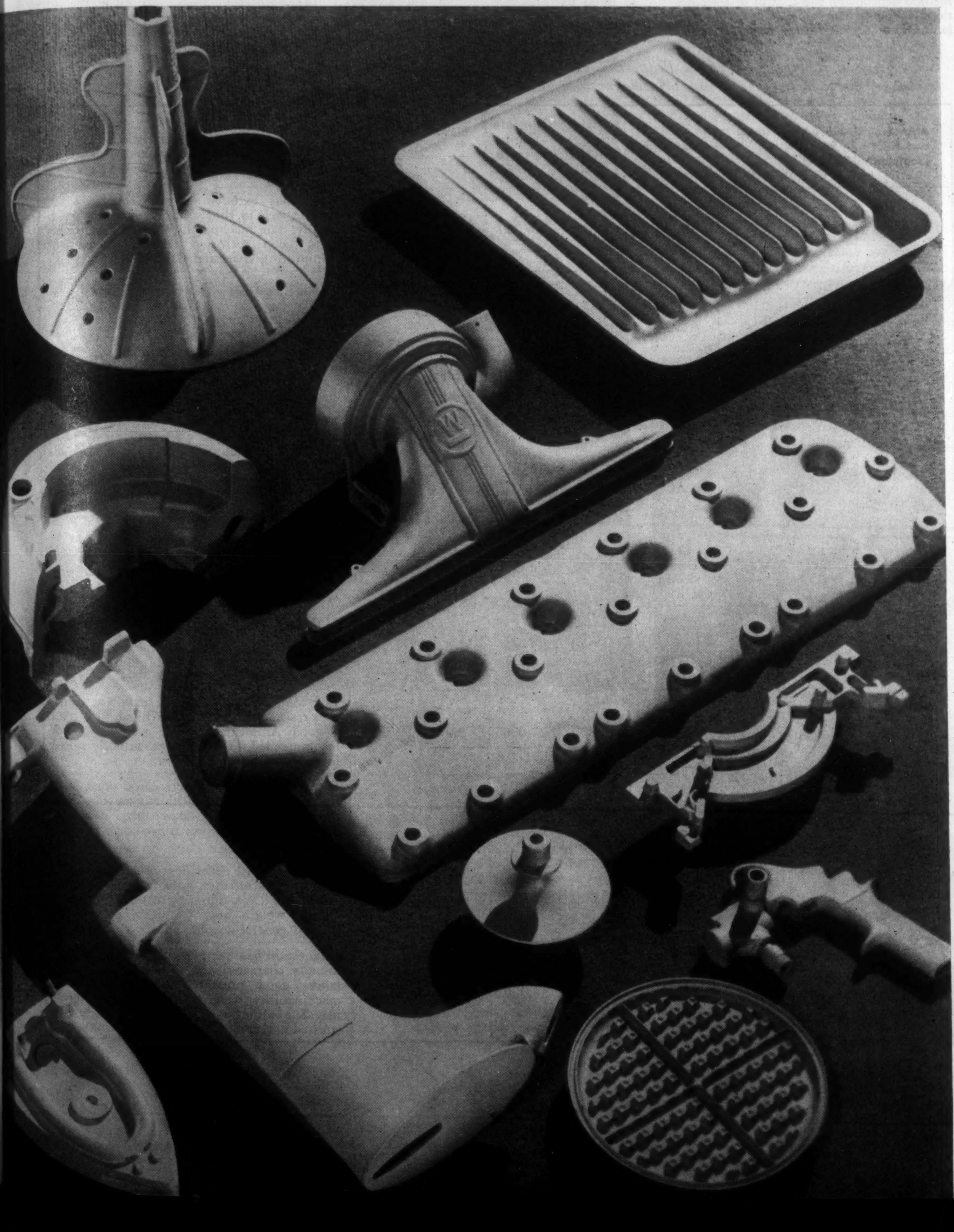
The mechanical properties, processing behavior and typical applications of the most important Al and Mg permanent mold casting alloys are given in Table III.

→

Fig. 1. Some old, familiar peacetime products made as permanent mold and semipermanent mold castings. Courtesy: Aluminum Co. of America.

Mold Design and Construction

Producers of permanent mold castings have always been reluctant to discuss the details of mold design, construction and operation, which they consider to be their stock in trade. The proper applications of design and procedure details certainly do make the difference between a casting which will meet stringent requirements and one which will not. It would be a monumental task to try to cover all of the points which must be considered in the proper design and successful operation of a permanent mold;



nor does the subject lend itself to generalization, since each casting is a problem in itself and the design of each mold should be individually approached, bearing in mind some of the fundamentals which we will consider here.

The production of a sound casting by any method depends on the control of solidification. In permanent mold castings of regular section, such as rolling slabs, or billets, it is not very difficult to attain progressive solidification. Castings for engineering use, however, are usually more intricate in shape and, therefore, solidification is not so readily controlled. The general design of the mold, its wall thickness, the location of cores, of light and heavy sections in relation to mold partings, the position and size of vents and chills, consideration of gate and riser size, and of gating and feeding positions should all be approached with the object in mind of securing progressive solidification in the casting.

It is far better to follow through on all design variables on paper rather than subsequently to take the elaborate steps necessary to rectify poorly thought out details. In a permanent mold, once made, the gates and risers are fixed and solidification conditions cannot be readily changed.

Table III—Typical Properties of Some Light Metal Permanent Mold Casting Alloys.
(An elaboration of a table in Swoboda's[7] article.)

Alloy No. and Heat Treatment	A.S.T.M Spec. B108-41T	S.A.E. No.	Composition	Yield Strength, 0.2 offset, p.s.i.	Ultimate Tensile Strength, p.s.i.	Elong. % in 2 in.	Brinell Hardness, 500 kg. load, 10 mm. ball	General Characteristics and Applications
43	9	—	5 Si, rest Al	9,000	24,000	9.0	45	Alloy has excellent casting characteristics, casting well in thin sections; excellent weldability; fair machinability; good lead tightness; good corrosion resistance; excellent Alumiliting characteristics.
B113	—	30	7-8.5 Cu, 1-1.5 Si, 1.2 Fe, rest Al	19,000	28,000	2.0	70	Excellent casting characteristics; a good general purpose alloy; excellent machinability; good weldability.
C113	2	33	6-8 Cu, 1-3 Si, 2 Zn, 1.2 Fe, rest Al	28,000	30,000	1.0	80	Excellent casting characteristics; good leak-tightness, a good general purpose alloy having greater leak-tightness and higher yield strength than obtainable in B-113 alloy.
A132-T551	6	321	11-13 Si, 2.5 Ni, 1 Cu, 1 Fe, 1 Mg, rest Al	28,000	36,000	0.5	105	Fairly good foundry characteristics; approximately 15 per cent less thermal expansion than in other aluminum alloys; good high-temperature properties, particularly in 500 to 600 deg. F. range; takes a good Alumilite coating. This alloy and heat-treat combination is used for cast pistons of all types and sizes.
138	5	—	10 Cu, 4 Si, 1 Fe, 0.15-0.35 Mg, rest Al	24,000	28,000	0.5	100	Excellent foundry characteristics; retains its hardness well at elevated operating temperatures. Used for electric hand-iron sole-plates.
B195-T6	1A	—	4-5 Cu, 2-3 Si, rest Al	33,000	45,000	7.0	90	This alloy in the condition noted combines good foundry characteristics with good physical properties, good machining qualities, and shock resistance. It is possibly the most generally used of the heat-treatable alloys.
A214	—	—	4 Mg, 2 Zn, rest Al	16,000	27,000	5.0	60	Fair foundry characteristics; excellent corrosion resistance; excellent machinability; takes a good Alumilite coating; welding is not recommended. This alloy particularly suited for cooking utensils.
355-T6	—	322	5 Si, 1.3 Cu, 0.5 Mg, rest Al	27,000	43,000	4.0	90	Excellent foundry characteristics; good leak-tightness; good weldability but must be heat-treated after welding; takes a good Alumilite coating; good corrosion resistance; good machinability.
AM240-T6 Alloy G	—	502	10 Al, 0.1 Mn, rest Mg	16,000	35,000	4.0	60	Magnesium base permanent-mold alloy. Good casting characteristics; good mechanical properties; good leak-tightness; excellent machinability; weighs only 0.066 lb. per cu. in. A good general-purpose alloy.
AM260-T6 Alloy C	—	503	9 Al, 2 Zn, 0.1 Mn, rest Mg	20,000	38,000	3.0	78	Magnesium base permanent-mold alloy. Good foundry characteristics; good corrosion resistance; good pressure tightness; excellent machinability; weighs only 0.066 lb. per cu. in. The alloy is widely used for highly stressed and intricate structural castings.

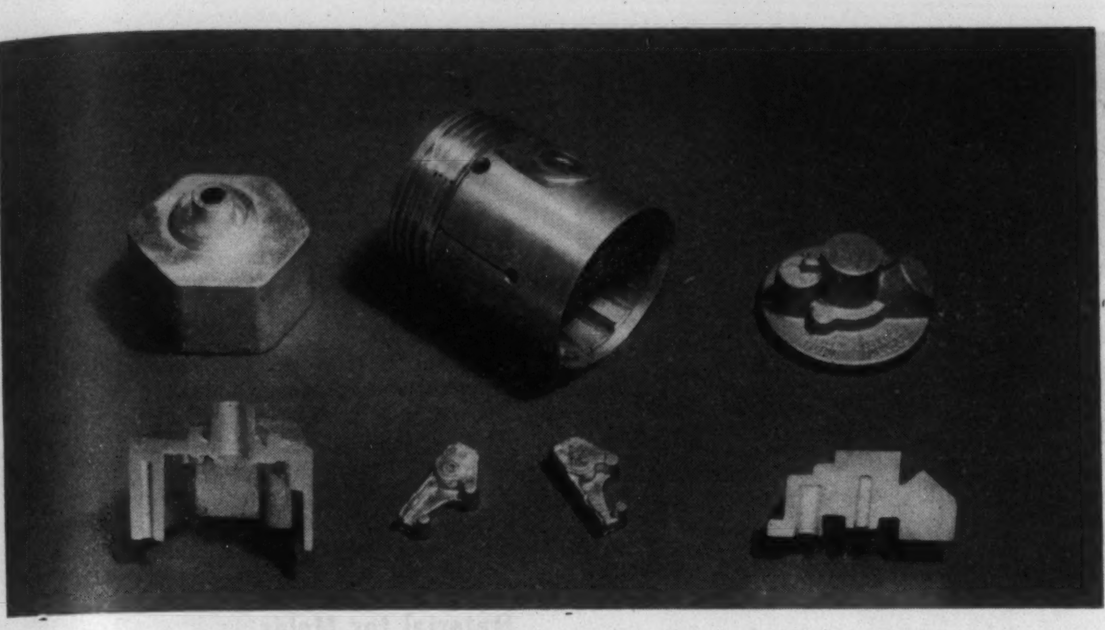


Fig. 2. Permanent mold castings in aluminum alloys as produced by the Permold Co. The sectioned castings show their freedom from porosity. The motor housing at the left was formerly a forging (from Fahlman & Chase[1]).

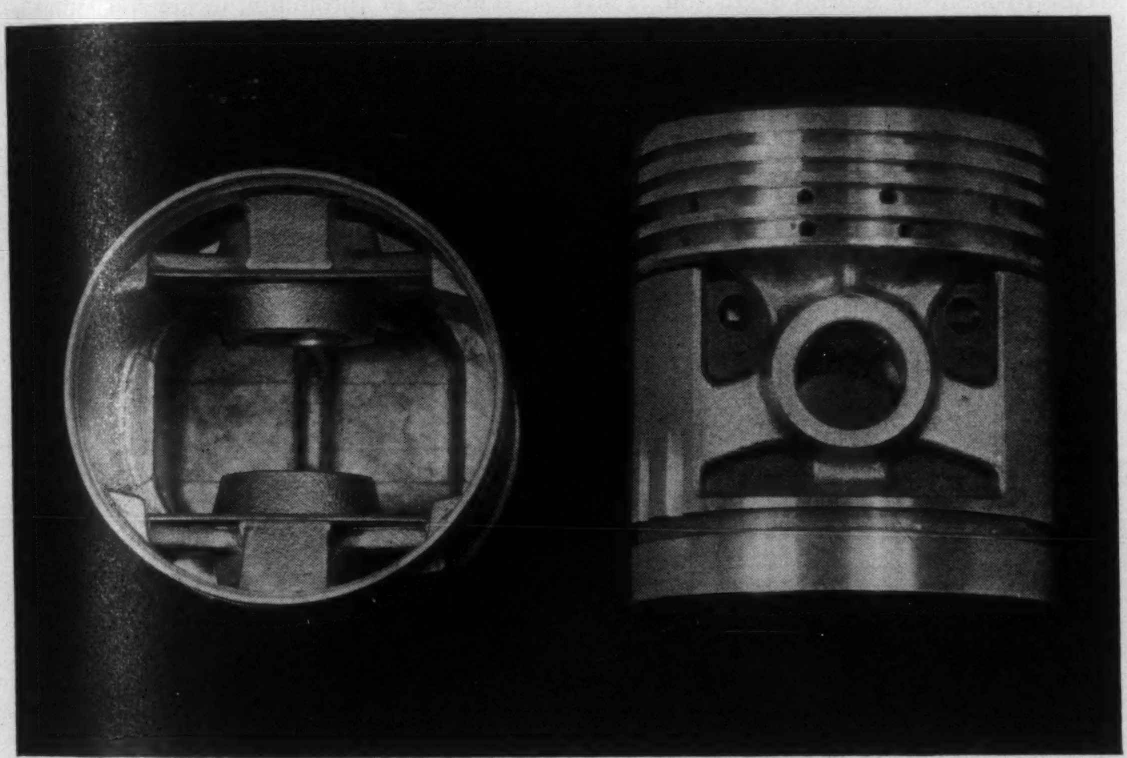


Fig. 3. Permanent mold cast aluminum alloy piston. To accommodate the undercutting the core must be made in 3 sections, which are removed separately from the casting (from Chase[2, 10]).

Mold design should not be considered simply as an engineering job, concerned with making a cavity in iron, arranging running channels into it and feeding cavities above it. Mold design requires all of the knowledge of the practical foundryman plus the ingenuity of the mechanical engineer. The advice of the foundry superintendent, who is in close touch with molds in operation, should be sought in all cases. He is in an excellent position to point out details covering variables which must be controlled in order to obtain efficient operation and satisfactory production from the unit under consideration.

Types of Molds

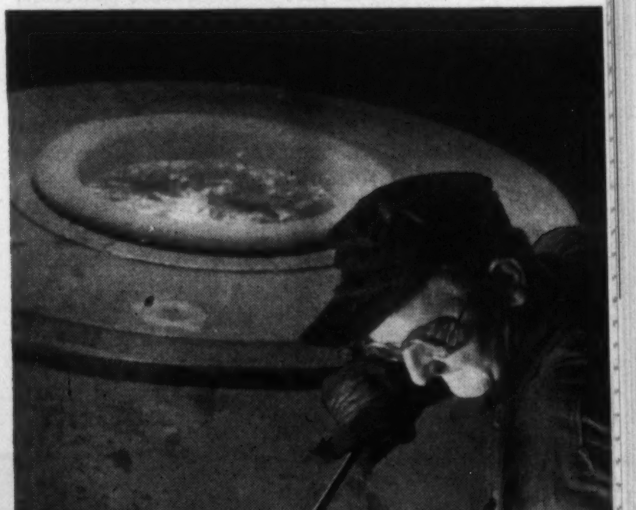
The simplest type of permanent mold is a cavity in one piece of metal into which molten metal is poured and allowed to solidify. The cavity should have sufficient taper to permit the removal of the solidified casting. Uncored castings of simple shape may be made in two-piece molds, each mold half providing part of the mold cavity. A gate may be cut in each mold half and a riser may also be provided. Other simple uncored castings may require a three-piece mold consisting of two mold halves and a base. The more complicated the casting the more complex is the mold.

Some of the more common types of permanent molds may be roughly and briefly discussed. A type of hinged mold for making simple castings has one mold half of which is stationary and mounted vertically on a base or some other means of support. The moving mold half is hinged to the stationary section by means of a pin. Cores or core pins may be pinched out by hand-operated pinch bar, pulled with a hand-operated toggle, rack and pinion or an air cylinder, depending on the size.

If the core is large, it is often made an integral part of the stationary mold half. Often the cavity for the casting is all in the stationary part and the moving segment acts only as a cover. Taper on the finished casting is so placed as to make it stick to the stationary part of the mold.

If there is a large core, it may be made to serve as the means of ejecting the casting, or should this not be practical an ejector plate mounted on the stationary mold half and containing several equally spaced ejector pins operated simultaneously by the plate may be used for removing the casting adhering to the stationary mold side. Repeated accurate alignment of the sections of the mold cavity in relation to each other is insured by doweling the mold sections to each other. Tight closure is insured by the use of hand clamps.

Fig. 4. Pouring a small aluminum alloy permanent mold casting into a mold that is split vertically and hinged about the pin in the foreground (from Chase[2, 10]).



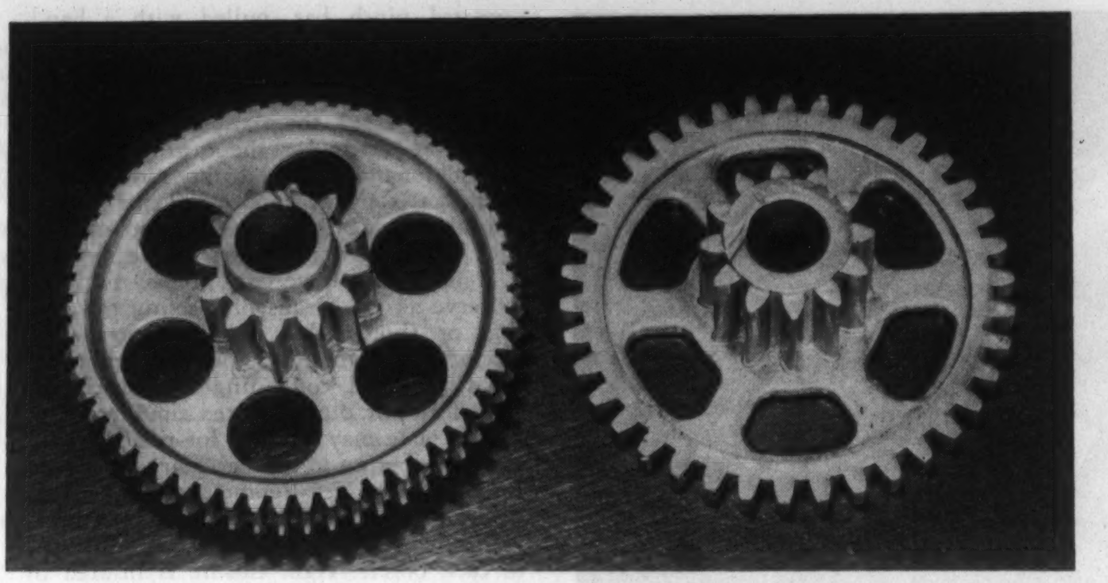


Fig. 5. Aluminum bronze gears, cast in permanent molds so close to size that the trim or shaving die need remove only 0.0005 to 0.0015 in. of metal (from Chase[2, 10]).

Molds such as just discussed are generally used to make comparatively shallow castings of small to medium size. A modification of this type of mold used for making a rather large box with straight sides and a great many bosses consists of a core forming the stationary mold side to which an ejector plate is also mounted; hinged to each side of the stationary segment are two equal mold sections which make the outside of the box and which swing away from the casting after it has been poured.

When deeper castings than considered above are to be made on the same type of mold, the movable half is supported independently. All of the mold segments are mounted on a base, with the stationary half bolted in position. The movable half is located by and moves back and forth guided by a keyway which is made an integral part of the supporting base. Again doweling should be used to insure the accurate alignment of the various mold segments.

To operate the movable mold segments a hand toggle, ram box, rack and pinion, air cylinder or hydraulic mechanism may be used. Cores and ejectors are again mounted and operated as previously discussed, generally by a rack and pinion. Hand clamps should be used when closure obtained with mechanical units is not positive enough.

Where core or casting is so massive that all mold segments must be moved to clear the finished castings, the mold assembly is somewhat different. When there are only two mold halves, one end of each may be pinned to the base. Both mold halves swing over to form the mold cavity and both are withdrawn from the casting to permit its removal from the base. In order to prevent the shifting of mold halves in relation to the core, it is wise to key the mold halves along the line of their closure—dowel pins insure proper alignment of the mold halves in relation to each other.

Cores extending vertically into the mold cavity from above may be sand or metal, hung by core prints on top of the mold halves and keyed to assure correct positioning. Metal cores may be pinched out with a bar or removed by mechanical means.

When the design of the casting calls for coring from the base side of the casting, the core, if sand, may be located in the base by means of a print or, if iron, it may be made an integral part of the base and operated by a rack and pinion. Such a core may be used to eject the casting, or an independently operated ejector plate may be mounted to the base. Small cores or pins through the mold sections are generally actuated with hand toggles.

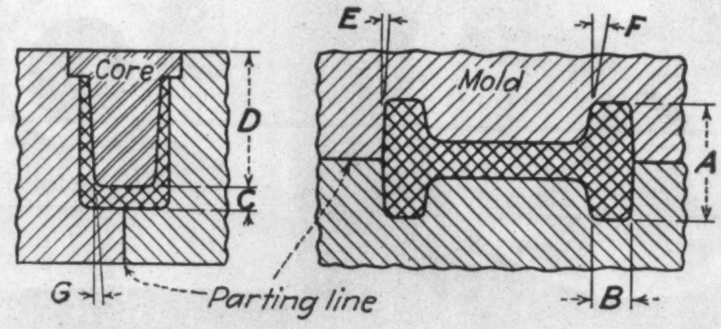
With a great many castings it is preferable to slide two or more mold segments in different directions to clear the casting rather than to swing them away by means of a simple hinge action. In such cases the various segments slide along the base guided and located by keys and operated by any convenient mechanism.

Where castings are large and heavy, mold segments may be hinged horizontally to the base. The casting cavity is partially cut in the base and the mold segments are pulled away by hand. Cores when large are mechanically operated and the casting freed by means of an elaborate ejector system. The casting may be lifted from the mold by hand or if very heavy by means of special tongs and a quick acting hoist.

The type of mold designed will depend on the particular casting and the specific practice of the foundry concerned.

Material for Molds

The mold segment—bases—large cores, etc., are generally made of a good grade of close grained cast iron. Varying percentages of chromium, nickel and molybdenum have been added to improve the hot properties of the base material, but any well made casting—easy to machine—will serve the purpose. Uniformly good results have been obtained by using special or high-strength irons like Meehanite for mold parts.



(A) ACROSS PARTING LINE: ± 1/64 for 1 in. or less—above 1 in. add 0.002 to tolerance per inch of length.
(B) BETWEEN POINTS PRODUCED BY ONE PART OF THE MOLD: ± 1/64 for 1 in. or less—above 1 in. add 0.001 to tolerance per inch of length.
(C) BETWEEN POINTS PRODUCED BY THE CORE AND MOLD: ± 1/64 for 1 in. or less—above 1 in. add 0.002 to tolerance per inch of length.
(D) MAXIMUM LENGTH OF CORE SUPPORTED TO ONE END: Diameter of core x 10.
(E) OUTSIDE DRAFT: 1° minimum—3° desirable.
(F) DRAFT IN RECESSES: 2° minimum—5° desirable.
(G) DRAFT ON CORES: ½° limited—2° desirable.

Note:
(1) Minimum diameter of cores = 1/4 in.
(2) Minimum web thicknesses for distance of:
    3 in. or less = 1/8 in.
    3 to 6 in. = 5/32 in.
    Over 6 in. = 3/16 in.
(3) Machine tool locating points should be indicated.
(4) Allowances for machining:
    Castings up to 10 in. long = 1/32 in. minimum, 3/64 in. desirable
    Castings over 10 in. long = 3/64 in. minimum, 1/16 in. desirable.
    Surfaces formed by sand cores = 1/16 in. minimum.
(5) Minimum radius of fillet:
    Radius should equal average thickness of joining walls.

Fig. 6. Design rules, tolerances and limitations for light metal permanent mold castings (from Swoboda[7]).

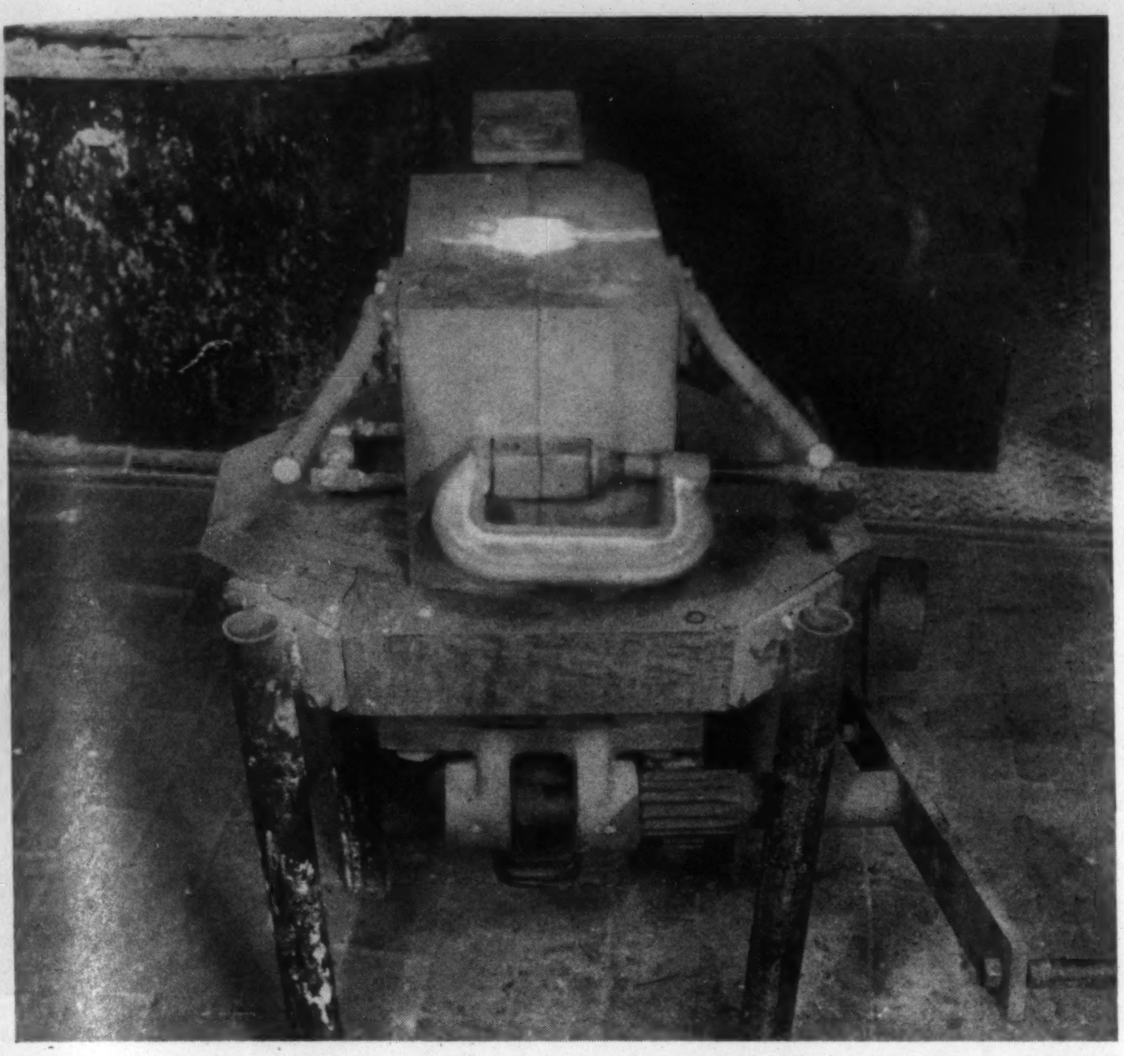


Fig. 7. A simple hinged mold, closed, ready for pouring.

When cores are intricate, collapsible, or take a good deal of punishment during casting operations, they may be machined from a medium tungsten high speed type of steel, treated to maximum hardness. Such cores are salvaged and kept in good repair by welding with high speed welding rod, remachining and re-treating whenever repairs are deemed necessary.

Gates, Runners and Risers

Provision of runners and gates for a casting may be compared to an assembly system. In the construction of a component, the various parts are brought together at the right time and joined carefully. Passing on, stage by stage, for each successive addition, until after a series of intricate and well planned operations, the fully assembled unit is produced. Everyone with a background of planning is aware that "bottlenecks" in an assembly line must be avoided. On the same basis, a skilled permanent mold designer avoids "bottlenecks" in running and gating.

In designing for light metals, he recognizes the fact that light metals are lazy and have to be helped to flow into the mold cavity. Hence light metal molding is characterized by the provision of numerous wide feeders and comparatively heavy risers, with a very definite tendency to counteract defects produced by incorrect feeding and gating with heavy risers.

The designer's goal is to make certain that gates and feeders are large enough and so placed as to avoid cold shuts and undue agitation and to supply ample flow of metal to fill the mold cavity at a satisfactory rate; that no one runner or section of a runner will be made to serve the purpose of two or alternatively will be made to contribute less than its share. The design, size and position of gates and runners must be such as to achieve maximum uniformity of heat distribution so that the solidification in the poured casting will be progressive.

The mold cavity should be so laid out that the heavy sections of the casting are at the parting, whenever possible, so that heavy sections may be fed directly by gate and feeder, or if their positioning be remote from the gate that proper risering be resorted to. It is preferable to have the casting in a permanent mold in a vertical position except for the tilt of the mold. However, should another pouring position offer operating or other advantages, the designer will not hesitate to lay out the mold so as to gain the benefits so derived.

In the design of the mold segments sufficient room should be provided around the cavity for alterations in size and position of gates, runners and risers. There must be sufficient height of gate and feeder so that enough liquid head is provided to insure filling all parts of the mold cavity. Should the mold as designed provide too much head, it may be cut away; if the head be insufficient, pouring blocks must be attached to the mold parts.

There should also be enough room on the sides of the mold faces to allow for gates and feeders and sufficient flat surface to make a good seal to prevent metal leakage at the time of pouring. Small and medium

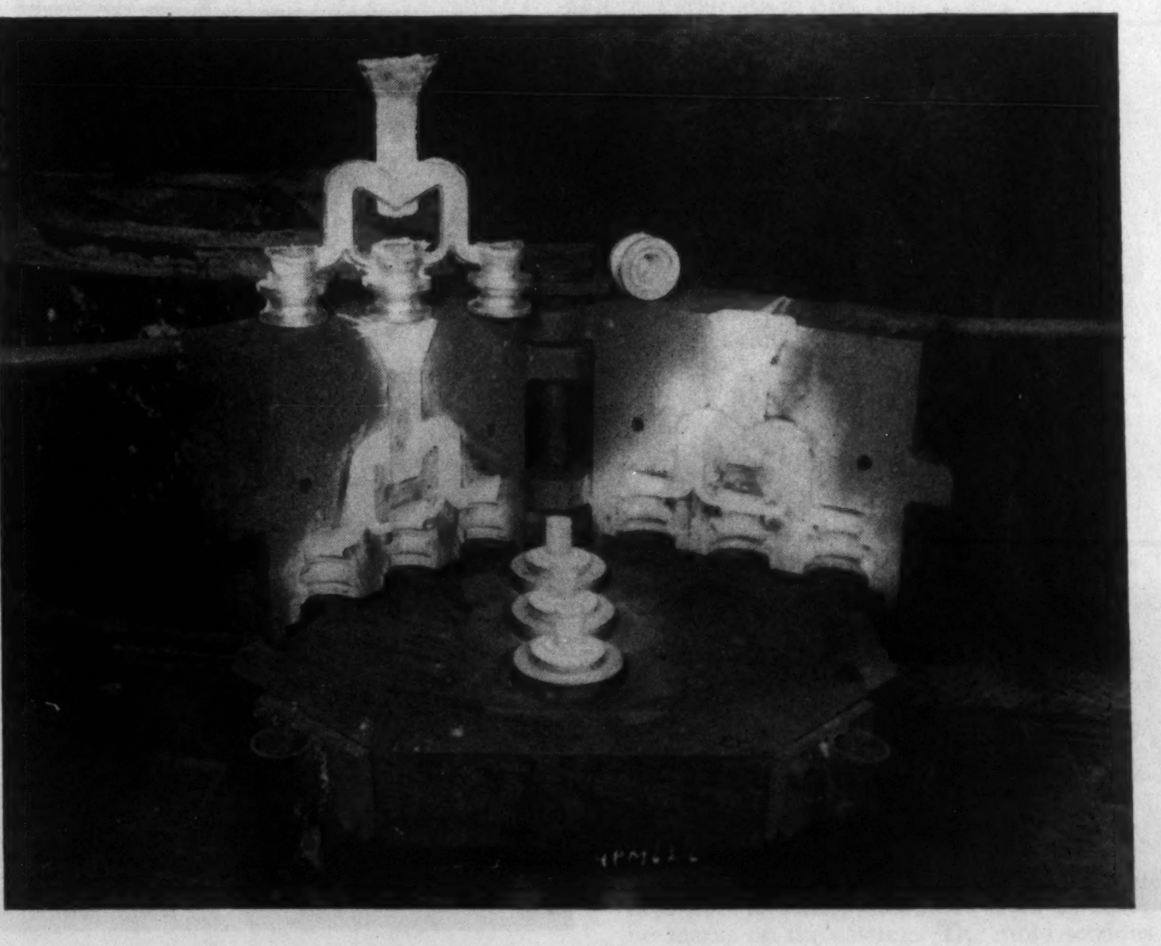


Fig. 8. Same mold as in Fig. 7, open to show the casting, mold-halves and core.

sized castings are filled through one gate from a single ladle. Larger castings may require as many as four gates, each fed simultaneously from a separate ladle.

Wall Thickness of Molds

It was formerly considered essential to make mold sections as heavy as possible because increased sturdiness in construction supposedly minimized warpage and cracking in mold segments. This meant increased operating difficulties due to exceedingly cumbersome molds. Another notion was that even though a long period of time was required to bring the heavy molds up to operating temperatures, once reached this temperature would stay more or less constant.

Present experience contradicts these old ideas. Uniform temperatures throughout the mold are not always necessary. More often a temperature gradient across certain sections of the mold gives the correct thermal conditions for the desired rate of solidification of the casting.

It is common practice to apply external heat to that part of the mold which forms the minimum section of the casting and may consequently receive too little heat to maintain the desired temperature in that part. It is more feasible, and from an operating standpoint preferable, to operate a lighter weight mold without the necessity for using external heat, and to depend on the heat given up by the metal during solidification to make up the losses due to convection and conduction. In extreme cases, it may even be desirable to cool very heavy casting sections which may be in too light mold sections by impinging a stream of air at the affected spot or by holding waste periodically wetted with water at such a section.

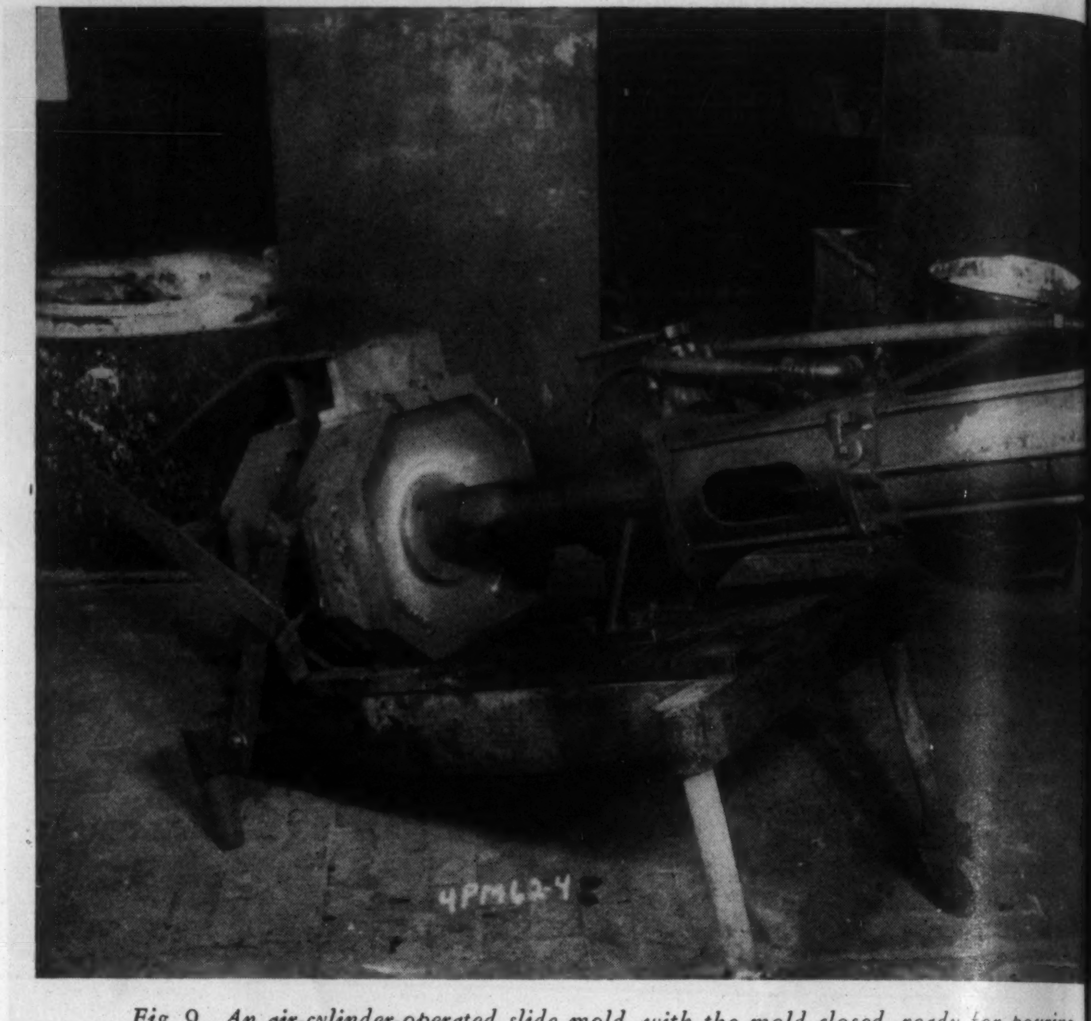


Fig. 9. An air-cylinder-operated slide mold, with the mold closed, ready for pouring.

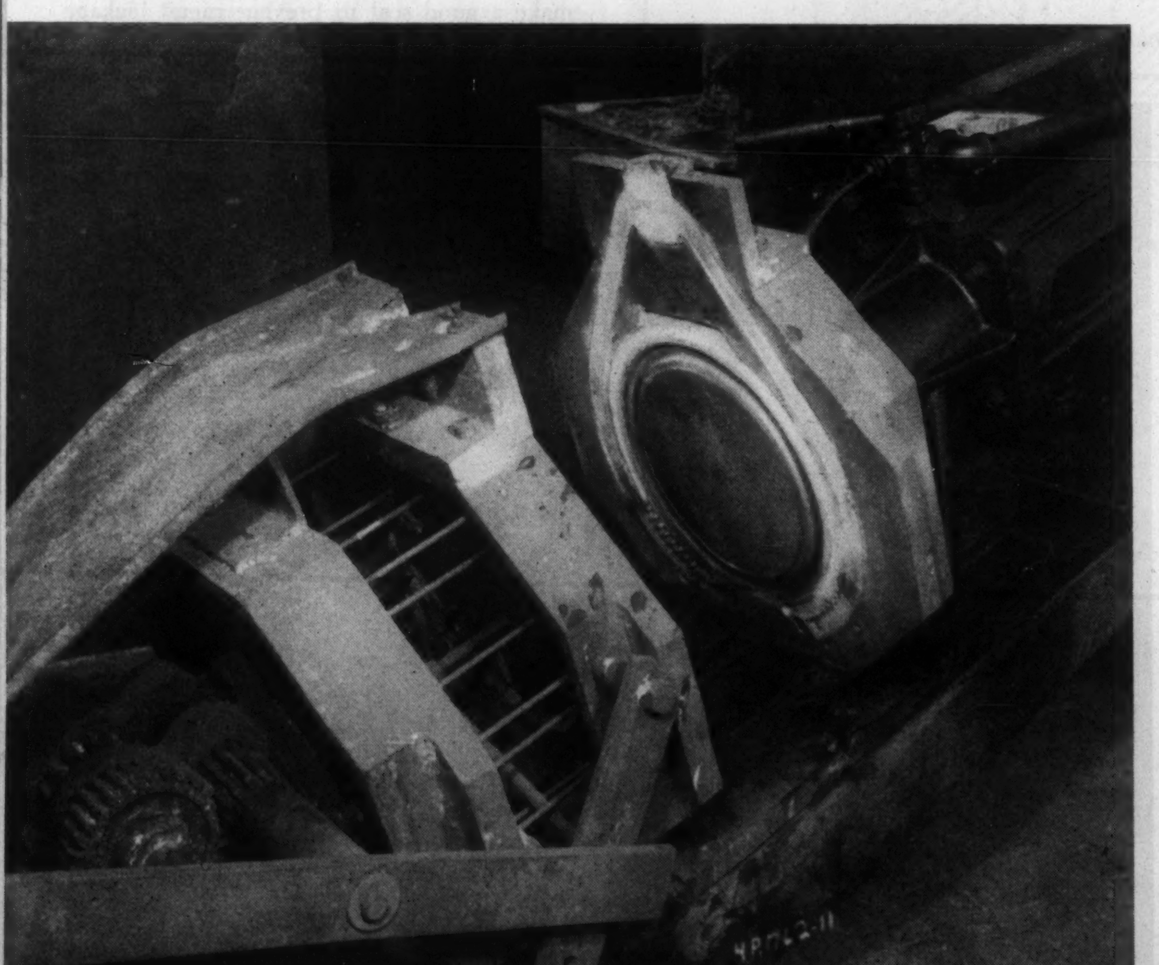


Fig. 10. Same mold as Fig. 9, partially opened to show the gating system.

There is no hard and fast rule for determining proper mold thickness. Some advocates of thin mold sections have suggested wall thickness of about three times the thickness of the casting. Permanent mold castings are commonly made in thickness of 0.080-0.090 in. This would indicate a mold wall thickness of 0.300 in. While such a light mold may be extremely fast, it probably would not have a very long life.

Molds of about twice that thickness, ⅝ in., have been built and have proven to be mechanically weak. Cracking at changes in mold section was quite prevalent even when all possible precautions for its preventions were taken. When used for making castings 0.125 in. thick, such molds were also found to be very sensitive to temperature fluctuations of either metal or mold.

When new molds with a wall thickness of ¾ to ⅞ in. were made for the above parts, the tendency to crack and warp was found to decrease. The sensitivity to temperature changes had also decreased but the molds were somewhat slower than those with the thinner wall section.

Nor can a mold thickness of three times the casting section be accepted for heavy castings, say ¾ to 1 in. in cross section. The resultant molds would be very massive, difficult to operate from a mechanical standpoint and difficult to control mold operating temperature. It must be remembered that in all molds, the supports and various operating sections in contact with the mold all carry away their share of the heat from the mold segments.

Therefore, mold segments need be no heavier than required to maintain the required temperature gradients. In general, mold sections need be no heavier than 1½-2 in. or slightly more for extremely heavy castings. It is good practice to have the mold contour follow roughly that of the casting to be made in it, so that the transfer of heat from metal to mold be on the basis of equivalent sections.

As in sand castings, but far more sparingly, chills find valuable application in securing an even rate of solidification and in influencing its direction. In permanent molds, chills are also pressed into service as vents as well as acting the conventional role of substitute for risers at inaccessible heavy casting sections.

The degree of chilling is controlled by the material and the length of the insert used for this purpose. Chills are generally copper, however, steel may be used when only small increases in chilling are desired. With venting always a problem in permanent molding, advantage is taken of the presence of all chills, and vent lines are invariably filed on the sides of the chill inserts. The application of chills can only be stated in general terms as the foundryman alone, with his skill and experience, can decide on the precise application of chills for each particular job.

Production Operations

The methods and practice described in this section are based on those used in this country and especially those with which the author has had successful experience. For an interesting and useful review of British practice, the reader should study the recently published paper by Vickers.[9]

Mold Preparation and Painting

A phase of permanent molding procedure passed over rather lightly by the uninitiated, is the art of mold painting. This phase of the process is really an art. Skill at the application and trimming of mold paint requires long practice before satisfactory results can be assured.

There are several proprietary paints on the market and every permanent mold foundry has its own pet formula. Basically all mold paints contain a refractory such as whiting, French chalk or a similar material, and a binder such as water glass, both suspended in water for easy application with a spray gun. A lubricant such as rouge or graphite may be added to aid the parting of mold segment and casting.

One paint which has been used successfully in production over a period of years is made up as follows: About 30 gallons of water in an appropriate container is brought to a boil. 7 quarts of 40% water glass are added and stirred into the boiling water. Then 10 lbs. of whiting are added and thoroughly dispersed through the boiling mixture and finally 1 pound of rouge or graphite is also added to the boiling material. The suspension is boiled for a few minutes longer—allowed to cool to room temperature and is then ready for use. The solid ingredients tend to settle out on standing. Therefore the paint should be well stirred before it is ladled into a spray gun prior to application.

A paint of the above type is used on mold faces, cores, gates, runners, risers, etc. —all sections that go to make up the mold cavity. Some cores and core pins that have a long stroke, in contact with the newly set casting, generally require more lubrication. This is supplied by water suspension of graphite applied periodically, as required, with a spray gun or after each cast by dipping the art into the graphite water suspension. It must be noted that such a coating will differ in thermal characteristics from the one produced by the above mentioned paint.

Prior to painting, molds are cleaned and heated to about operation temperature which is in the neighborhood of 700 F. When a new mold comes out of the machine shop, an individual pipe burner should be made for it. The burner should be so constructed that the entire mold is uniformly heated and distortion due to unequal expansion is kept at a minimum. The various mold segments, which have been previously normalized after rough machining to relieve strains, are assembled.

Using the newly constructed burner, another long, rough normalizing treatment should be given to the assembled mold. During this treatment all mold faces should be tightly clamped together—the cores are left loose and the heat applied from the outside is gradually increased to the desired temperature and held at temperature for a few hours or days depending on the size of the mold. By such treatment possibilities of cracking and warpage of the mold are kept at a minimum. Should any distortion or warpage take place during the treatment the mold parts are refitted.

The hot mold is then disassembled for painting. The sections to be painted are slightly roughened by a light sand blast in order to make the paint stick better. A light coat of paint is sprayed over all parts of the mold which are to be covered. This coat is rubbed down with steel wool.

Painting and rubbing down are continued until a tightly adhering layer of the proper thickness has been applied. The average thickness is around 0.002 in.—lighter or heavier in different sections depending on the chilling effect desired.

A skilled painter will finish a job with two to three coats and finish all the gates, runners and risers which require a much heavier coat by applying additional paint to these areas with a hand brush. The thickness of the paint in critical sections is trimmed by scraping to the proper thickness and is finally smoothed over to leave no marks on the casting. The mold sections are then reassembled, the mold closed and

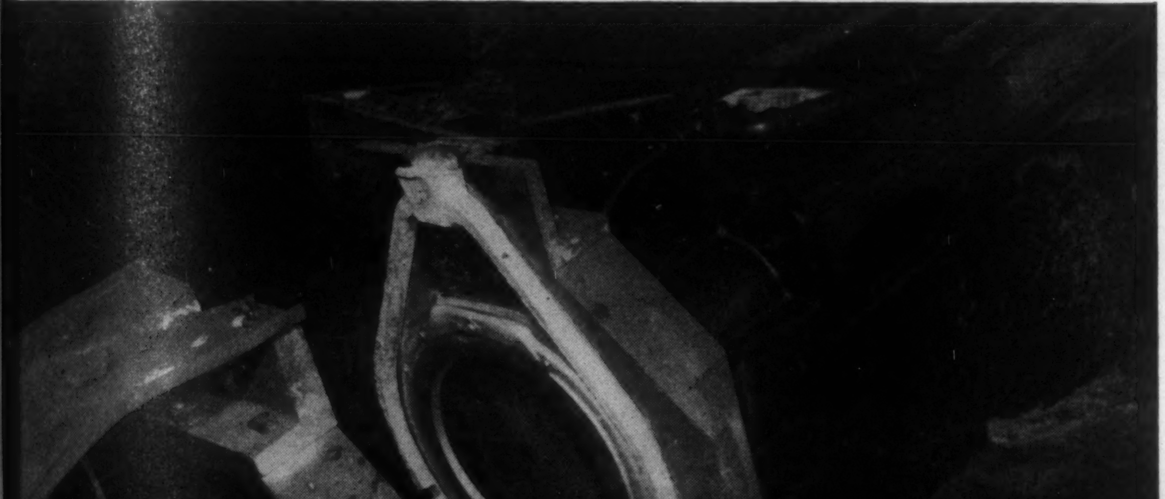


Fig. 11. Same mold as Figs. 9 and 10, fully opened, showing the ejected casting.

reheated to operating temperature with its burner.

A good paint job should last through 24 hrs., more or less, of continuous production, depending somewhat on the number of pours, the size of the casting, the rate of operations, etc. It is generally necessary to make minor repairs and trims on the paint intermittently through the production period.

The painted surface should not be too smooth. Among the properties of the paint which are taken advantage of are its ability to enable the metal to lie quietly against the mold face, to help control the solidification of the casting, and to protect mold sections against erosion by molten metal.

The modification of paint in thickness or type will influence the rate of solidification of the casting. The thickening of the refractory paint in certain areas will delay solidification at that point appreciably. Hence, gates, runners, risers, thin areas of the casting are among the sections which are given a heavier than normal coat of paint so that heat is retained and thus other sections of the casting fed more effectively. At sharp changes in section, it is customary to remove the paint altogether and so provide chilling.

Elaborately trimmed paint jobs should be avoided because of difficulties in exact duplication. It is wiser to study possibilities thoroughly and obtain control of progressive solidification by other means, such as gate or riser changes, by application of heating or cooling to the affected area of whatever other steps may be effective, rather than to try to obtain this control only through paint.

On a mold in production, the paint wears progressively smoother and becomes less and less effective, until misrun castings become quite common. When this point is reached, it is advisable to remove the old paint with a wire brush or a light sand blast, and then reheat and repaint the mold as previously outlined.

It is not good practice to bring a cold mold previously painted, from room temperature up to operating temperature—unless only sample castings are to be made. The difference in the expansions of the paint and the mold will cause the paint to crack or pull away from the mold in spots as operating temperature is being reached. Results under such conditions will not be satisfactory.

The action and application of mold paints warrant a thorough investigation. At present, paint formulation, application and trimming are done more or less haphazardly. With the successful operation of an expensive mold depending on the mold paint properly applied, this seemingly trivial subject becomes one of major importance. Much more accurate scientific data on this phase of permanent mold practice should be made available to the industry.

Pour Control and Venting

Efforts have long been made to eliminate the human element factor in the pouring of a permanent mold casting. When the pour is too hard, the metal is agitated and likely to trap and carry air and dross over into the mold cavity; when the pour is too easy misruns are prevalent. Control may be partially attained as follows:

(a) By putting a sump at the base of the gate. Such a device will not in itself be fully effective but will help decrease possible turbulence;

(b) By making the volume of the feeder about one-third greater than the volume of the gate,—thus slowing down the rate of flow into the cavity;

(c) By drastically choking the stream of metal from gate to runner. Either by means of multiple fingers, at various levels, tapering from runner to gate and so placed as to flow metal upward from gate to feeder, or by means of a fan slit arrangement tapering from the gate to an opening slightly more than the thickness of the casting at the feeder;

(d) Or a gooseneck curve in the gate, supplemented by a fan, may be used as a method to control pour. The tapered fan slit from gate to runner contributes to positive pour control but places almost the entire burden of making sound castings on the shoulders of the designer, for the gate, riser, feeder, etc., must be exactly right to produce sound castings.

This is quite a difficult problem, especially in castings where the sections vary drastically in mass. In castings with changing sections, it would be ideal to vary the rate of flow of metal into the mold cavity with the changing mass of the casting. When metal feeds through a tapered fan slit no changes can be made in the rate of flow into the mold cavity because the slit affords a positive choke and no casting can be poured too "hard" unless the slit is too open.

Thus scrap due to blow holes and castings containing hard spots are kept at a minimum. With a more open connection between gate and runner a good mold operator can determine at what rate to pour different sections of any castings after he has made a few trial pours.

When multiple tapered fingers are used to connect gate to runner, the operator has partial control over the pour and may vary it to suit the varying mold sections. The connecting fingers are also so located as to feed massive sections more readily, and eliminate any necessity for change in the rate of pour. With this set-up, fewer obviously scrap castings will be made but it must be remembered that the pourer has at best only partial control over possible turbulence and its resultant defects.

From the gate, the metal filling the mold cavity flows into a side runner or riser, or, in some cases of horizontally placed cavities, into a riser directly over the casting. The side feeder or runner should be about one-third larger in cross-sectional area than the gate.

The purpose of this is (a), to slow down the rate of metal flow and thereby reduce possible turbulence, (b) to make the flow of metal into that part of the mold cavity which forms the casting easy and uniform, and (c) to feed the casting, offsetting crystallization and contraction shrinkage. The feeder should be shorter on both bottom and top than the gate, but provisions should be made at the bottom for a small sump and at the top for a small pressure ball.

A slit extending almost the length of the runner acts as the inlet for metal from runner to casting cavity. Only the sump and pressure ball are not tied into the casting. The width of this slit inlet should approach the thickness of the casting at the point it ties in. About 0.010 in., generally less, should be left to serve as a witness mark for use as a guide when trimming the gate off the casting.

When the casting is filled directly from the riser, the same general procedure is followed, the inlet increasing or decreasing in cross-section with changes in thickness of sections of casting being fed. Slit inlets are used in order that hot metal will be supplied to solidifying zones to decrease the tendency for porosity due to over long solidification periods which would be produced with the hotter metal or locally over heated mold sections.

There is generally the tendency to carry the too large solid risers used in sand casting over into permanent mold designs. Such large risers, with their long solidification time, slow down production, cause local over-heating of the mold and are responsible for draws and shrinks in adjacent areas. In theory, little more metal is required in a riser for feeding, than that necessary to compensate for contraction in the volume of the metal in the section being fed by it.

Incidence of unwanted draws and porous areas due to too long solidification time can be greatly reduced if design is such as to give even solidification from the bottom upward. Risers are best used and considered as devices to supply metal to make up crystallization and contraction shrinkage, rather than as arrangements to force metal down into the body of the casting in order to hold up a thick section by sheer fluid head. As stated before, riser sections should follow the general contour of the casting sections which they feed with the inlets opened as much as possible, leaving only a witness mark for trimming.

Unfortunately iron molds do not have the permeability of sand molds. Therefore venting is ever a problem with a permanent mold foundry.

Holes, too small to allow metal to flow through but large enough to allow gases to escape, are drilled through mold sections wherever they will not affect the casting contour or surface. Vent lines are filed from the mold cavity to vent holes and to the outside of the mold. Risers are cut open to furnish exits for air in the mold cavity as well as to serve as a guide for stopping the pour. Molds in operation are tilted and so poured as to allow for maximum venting.

When castings contain large flat areas, generally very difficult to pour in a permanent mold, extra venting must be supplied for such sections. This is done by judiciously placing plugs over the area in question and filing numerous vent lines on the circumference of each plug to permit the escape of air from these sections. Remote heavy sections are also vent plugged to allow the voiding of air which might otherwise be trapped and create enough back pressure to prevent filling of the mold cavity. Ejectors and core pins are also placed and used to give most advantageous venting.

The sand cores of semi-permanent mold castings are themselves elaborately cored and criss-crossed with vent lines to permit the free passage of air and core gases. No permanent or semi-permanent mold can be vented too much.

The Pouring Operation

The overall control of the temperature of a mold in operation is not simple. Mold temperature is controlled through accurate control of the pouring temperature of the metal being cast, by the rate of mold operation, by the thickness and trim of the coat of refractory paint, by the thickness of the mold sections, and by the application of external heating or cooling. But successful mold operation is often obtained in spite of rather than because of real temperature control.

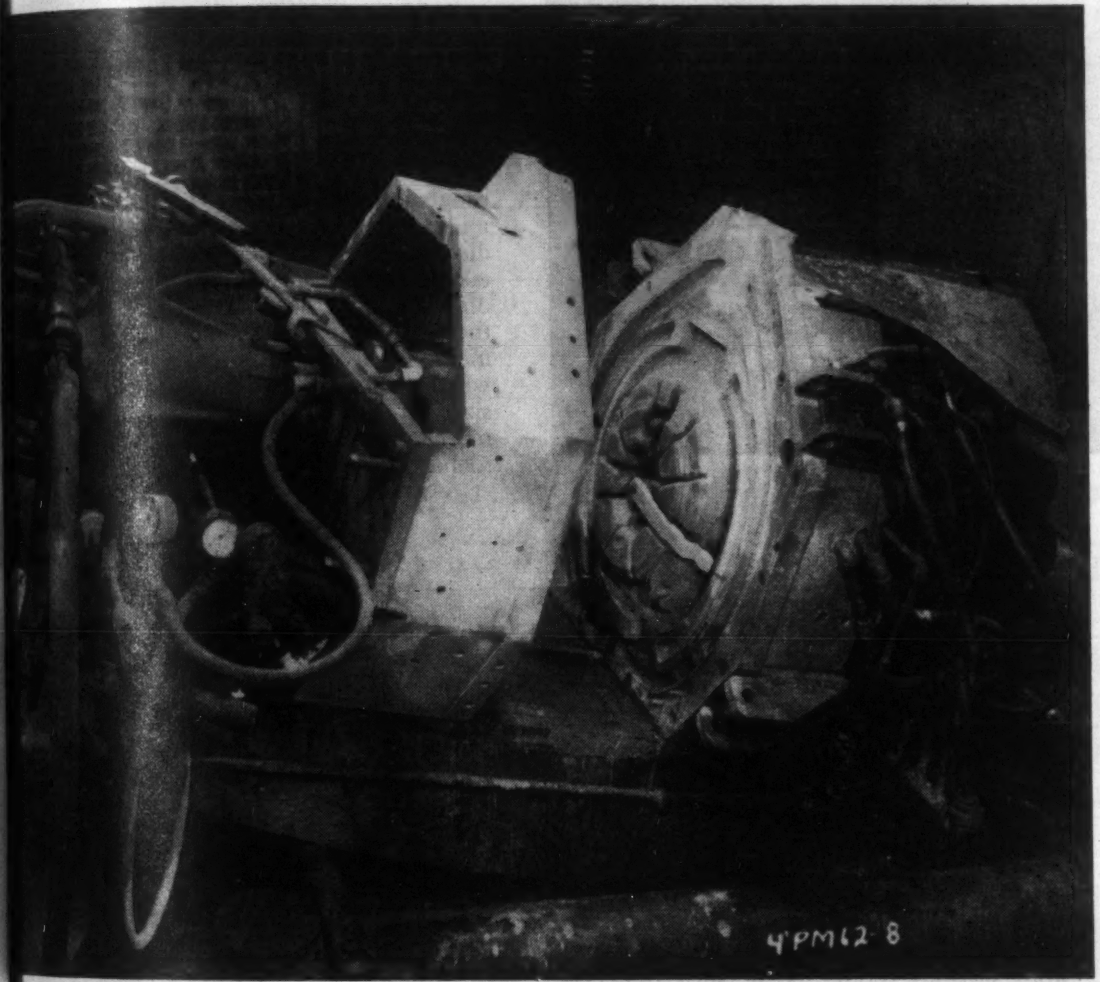


Fig. 12. An air-operated semi-permanent slide mold, with the sand core in place.

There are probably limiting maximum and minimum temperatures between which a mold will operate successfully. It may be necessary to apply external heating or cooling to maintain the mold at equilibrium between the limiting temperatures. Each mold has its own temperature range/time cycle which should be experimentally determined before the mold is put into production. Once determined this temperature range/time cycle should be closely adhered to.

For example, a casting weighing one to two pounds, of comparatively uniform section and not too complicated coring can be produced at the rate of 35-40 castings per hour at a mold temperature in the neighborhood of 600-700 F, which is a good operating temperature. The pouring temperature and the exact number of pieces to be cast per unit time are accurately determined experimentally. Should external heating or cooling be necessary in order to make good castings, the means for doing so are made an integral part of the mold.

In production, the operator makes all necessary adjustments prior to making any pours. He paces himself to obtain exactly the predetermined number of pours per unit time. Should he be unfamiliar with the mold or himself be inexperienced, he should use an interval timer to pace his mold operation. It is essential that metal temperature be closely held and controlled and that the body of metal being ladled and poured into the mold be large enough to supply metal for continuous production without any undue temperature fluctuation.

This may be done with a large central melting unit from which molten metal is carried to a holding pot of sufficiently large capacity. The holding pot is kept at a constant temperature with an automatic control unit. Where a great many different alloys are melted, smaller units such as large tilt pots are used to supply molten metal to the holding pots which in turn supply metal at a constant pouring temperature to the molds.

A third method is to melt in small reverberatory furnaces 2,000-3,000 lb. in capacity. These units may be charged through a door or well on the back of the furnace and molten metal may be ladled out of one or two wells at the front end. Ingot and scrap are charged at about the same rate as molten metal is being poured. This rate should be such that the automatically controlled pouring temperature does not fluctuate during the time the unit is in production.

Gas and oil are the most commonly used fuels for melting in a permanent mold foundry.

The pouring temperature of a permanent mold casting is partially determined by its size, section thickness and intricacy; by all the variables that affect the mold; and by the alloy being cast. Normally, the pouring temperature for aluminum alloy castings should be in the neighborhood of 1300 F to 1450 F.

The lower the temperature at which good castings can be poured, the easier will be the control of the many variables in the process. High temperatures have a tendency to cause draws, cracks and general porosity by increasing the solidification time. Inclusions which adversely affect machinability, and gas pin holes are also a direct effect of too high temperature before pouring.

It cannot be too strongly emphasized that the casting cycle in terms of castings per unit time should be continually duplicated. It is far more economical to produce, say 30 good castings in one hour than to make 40 pours in the same unit time and end up with 30 good and 10 scrap castings. Not only will the loss in labor efficiency be noted at the end of the day but there will also be the fuel and metal loss during each melting of the original ingot and subsequent remelting of scrap castings each time they are produced.

It is quite evident in most permanent mold shops that mold operating temperatures are not given the attention warranted. This may very well be the reason for the unsuccessful operation of a great many molds.

Some General Notes

Great care should be taken in removing work from the mold. The building of special tongs for removing castings from every mold in production is a precaution which will pay dividends by reducing the number of distorted castings. Castings removed from a mold should preferably be placed in a warm place rather than directly on a cold floor. Should this precaution be adhered to a partial anneal will result and the tendency of the casting to crack due to rapid temperature change while it is unsupported will be decreased. If on subsequent machining, the castings distort after the cast surface has been removed, a full anneal should be adopted as part of the regular manufacturing procedure.

Castings should be held in a vertical position until cold, especially if massive sections are located in the base. To decrease the tendency for distortion, especially in large castings, they should be so placed as to avoid a cantilever action from the riser or any other heavy section acting as a weight.

The mechanical operation of all parts of a permanent mold must be smooth and

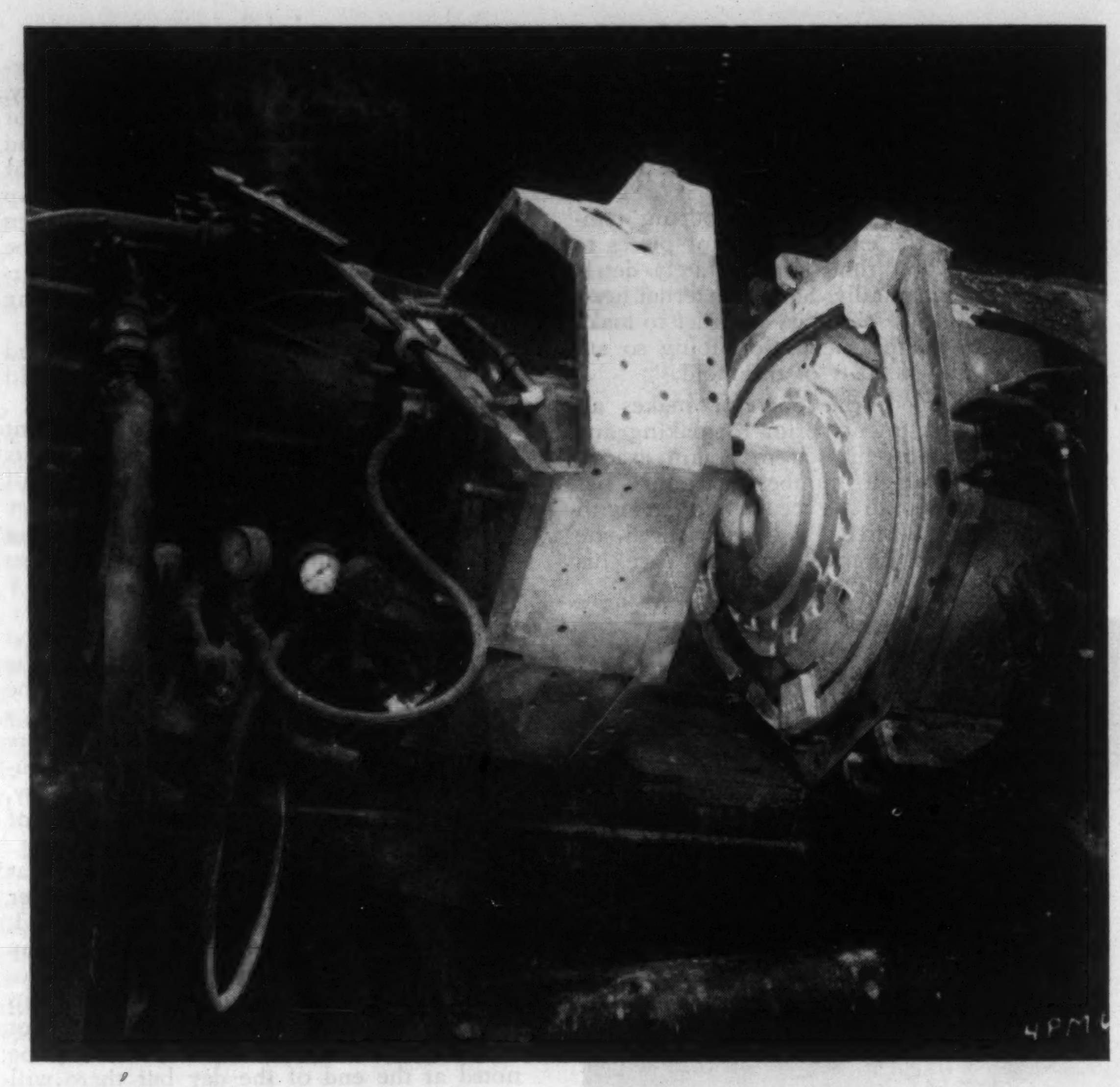


Fig. 13. The same mold as in Fig. 12, with the casting in place.

free. Not only must the heavy work of the operator be kept at a minimum but the following facts must also be remembered: —(a) light alloys have little strength while hot, (b) a casting left too long in the mold after the metal has set will crack and distort, (c) if the time in the mold is further prolonged, the casting will freeze onto a core or mold segment, in which case the metal must be melted in order to free it from the mold parts.

It is therefore evident that smooth easy parting for cores, mold sections and ejectors from the solidified casting is essential if scrap is to be avoided. Sufficient fillets must be provided to prevent cracks at changing sections and directions on the casting. 1-3° taper should be provided for easy withdrawal of otherwise straight mold section or of casting from core on which it solidifies.

Mold sections, cores, ejectors, etc., must fit snugly and seal positively during the pour so that the dimensions of the casting may be closely held and leakage of molten metal be prevented. Fins produced in poorly closing or fitting molds are a source of trouble and annoyance. The operation of the mold may be made difficult by the freezing of a fin to an undercut at a core, ejector or mold parting. It may hold the rough casting more or less securely to a mold segment and be the direct cause of distortion when difficulty is encountered in taking the casting out of the mold. The dimensions of the castings will deviate from the desired by the thickness of the fin. The method selected for operating and sealing will be influenced by the casting design, the size of the mold sections, the availability of mechanical equipment, the number of pieces to be cast, etc.

Summary

As a general summary we may say that permanent molding is a not too complicated method for making castings in volume. Complex coring in itself need not rule out the permanent mold process since sand cores can readily be used in conjunction with iron molds. There are certain advantages of permanent mold over sand castings, among them are better physical properties and savings in machining time and cost.

The control of solidification through gating, mold design, pour, temperature control, etc., is an ever present problem which must be approached from a practical angle since necessary scientific data are lacking. Unless all variables are held in check, sound castings in volume will be very difficult to produce.

The control of pour by means of choking the stream of metal offers disadvantages as well as advantages. There should be a riser on almost every permanent mold cavity but care must be taken to keep the size of the riser such that it will accomplish its purpose and not be so large as to be another source of difficulty. Venting and chilling are necessary variables best left to the discretion of the foundry superintendent.

Mold sections must be adjusted to fit closely and tightly so that casting size may be maintained and production go on efficiently. The mechanical operation of the mold must be free and easy because of the hot shortness of the alloys used in the process. Finished castings must be handled gently in order to minimize possible warpage.

The type and application of refractory mold paint is an art that requires close and constant attention. A little common sense should be applied to heating up of the mold going into production so that stresses due to unequal heat expansion are not built up. Mold sections should be of such thickness that maximum mold life and production will be attained.

A temperature range/time cycle should be established and maintained for every mold in production. Close control of metal pouring temperature is one means of controlling mold temperature and casting soundness.

This discussion has tried to point out the design possibilities and limitations of permanent mold castings as well as the many pitfalls in the path of a permanent mold foundryman. That he has been able to avoid them and make a good commercial product indicates that the permanent mold foundryman is resourceful and that the process has inherent possibilities.

Care and practice have shown that all the variables in the art will lend themselves to ready control in production. On the merits of its products alone, the permanent mold casting industry has established itself as a large and rapidly expanding source of quality castings for engineering use.

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METALS and ALLOYS

Engineering File Facts

NUMBER 78
April, 1945

MATERIALS AND DESIGN
Stainless Steels

Stainless Steels—Basic Types

Group I—Martensitic

Primarily straight chromium steels. These types are hardenable by heat treatment. They are magnetic; can be cold-worked without difficulty, especially the low-carbon types; show satisfactory resistance to weather, water, and to some chemicals; can be machined satisfactorily; free-machining types have sulphur or selenium added; show good toughness; are easily forged or otherwise hot-worked. Corrosion resistance is usually improved by the hardening process, but temperature ranges must be watched closely in the case of the high carbon grades. They tend to air-harden from above 1500 F., and welds made by electric arc, resistance, or gas techniques show hardening of this type. Strength up to 1200 F. is superior to that of carbon steel, and scaling resistance is good over the same range. They are not subject to excessive grain growth at elevated temperatures.

AISI Type No.	Composition				Hardening Temperature	Properties or Uses
	Carbon	Chromium	Nickel	Other Elements		
403	0.15 max.	11.5-13.0			1750-1850 F.	Widely used for forged turbine blades
405	0.08 max.	11.5-13.5		Al 0.10-0.20		Non hardening when air cooled from high temperatures
406	0.15 max.	12.0-14.0		Al 4.00-4.50		For electrical resistances; aluminum also reduces air-hardening
410	0.15 max.	10.0-14.0			1750-1850 F.	A low-priced general purpose heat treatable stainless steel
414	0.15 max.	10.0-14.0	2.00 max.		1800-1950 F.	For springs, knife blades, tempered rules
416	0.15 max.	12.0-14.0		S or Se 0.07 min., or Mo 0.60 max.	1750-1850 F.	A free machining grade
420	over 0.15	12.0-14.0			1800-1900 F.	For cutlery, surgical instruments, valves, ball bearings, magnets
420F	over 0.15	12.0-14.0		S or Se 0.07 min., or Mo 0.60 max.	1800-1900 F.	A free machining variation of 420
431	0.20 max.	14.0-18.0	2.00 max.		1800-1950 F.	For good hardenability
440A	0.60-0.75	14.0-18.0			1850-1900 F.	For instruments, cutlery, valves—high hardness obtainable in high-carbon grades
440B	0.75-0.95	14.0-18.0			1850-1900 F.	
440C	0.95-1.20	14.0-18.0			1850-1900 F.	
501	over 0.10	4.00-6.00			1600-1700 F.	Corrosion resistant rather than stainless; good strength at elevated temperatures
502	0.10 max.	4.00-6.00			1600-1700 F.	

Group II—Ferritic

Chromium steels, not hardenable by heat treatment. They can be cold-worked or hot-worked, are magnetic, less tough than the martensitic types, usually show excessive grain growth upon prolonged exposure to elevated temperatures, and may develop brittleness after electric arc, resistance, or gas welding. They show better high temperature strength than carbon steels, but lower values than the martensitic group. Scaling resistance is better, however, as is corrosion resistance in general. Machinability is good, and can be improved by adding sulphur or selenium to the composition. They show no tendency to intercrystallar corrosion.

AISI Type No.	Composition				Properties or Uses
	Carbon	Chromium	Nickel	Other Elements	
430	0.12 max.	14.0-18.0			An easily formed stainless alloy, much used for automobile trim, chemical equipment, etc.
430F	0.12 max.	14.0-18.0		S or Se 0.07 min., or Mo 0.60 max.	A free machining variety of 430
442	0.35 max.	18.0-23.0			For high temperature service when ease of fabrication is not required
443	0.15 max.	18.0-23.0		Cu 0.90-1.25	An easily worked steel of high corrosion resistance—for chemical equipment, and elevated temperature use
446	0.35 max.	23.0-30.0			High corrosion resistance and scaling resistance to 2150 F.

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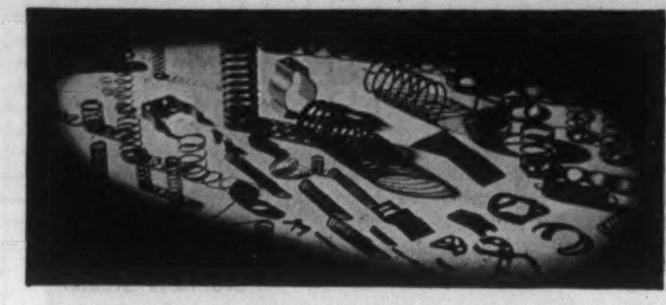


The I-S SPRINGBOARD

VOL. 2 NO. 3

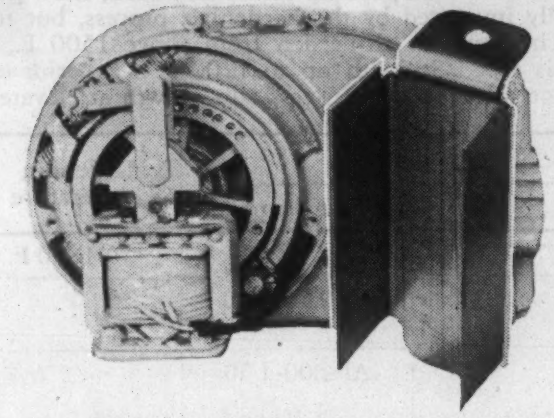
Published by INSTRUMENT SPECIALTIES CO., INC.

224 BERGEN BOULEVARD LITTLE FALLS, NEW JERSEY

FILEWORTHY FACTS ABOUT MICRO-PROCESSED BERYLLIUM COPPER

MICRO-PROCESSED BERYLLIUM COPPER SOLENOID GUIDE OUTLASTS OTHER MATERIALS BY MORE THAN 10 TO 1

Yale & Towne Reports No Service Failures After Standardizing on BeCu^{mp}

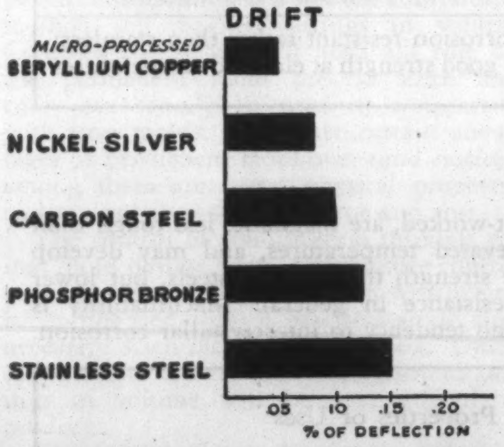


Beryllium copper^{mp} solenoid guide (illustrated with the complete assembly of which it is a part) was chosen over all other materials after exhaustive tests to obtain longer service life under the most severe operating conditions. The problem facing Yale & Towne was to find a non-magnetic material with sufficient wear resistance to withstand the file-like action of the solenoid core which rides in the guide without lubrication.

The shape of the guide must be held to close tolerances since the core or plunger must ride entirely free, yet its motion must be guided accurately. Micro-processing provides the answers—the guides are formed from specially annealed .057" beryllium copper stock, and are then placed in heat treating fixtures which hold the exact required clearance during the hardening heat treatment.

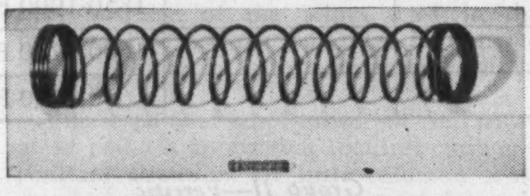
The best material previously available failed after 200,000 operations of the magnetic brake of which the solenoid is a part. No failure has been reported on the micro-processed beryllium copper guide after 3,000,000 operating cycles. The successful production of this solenoid guide which is used in the Yale & Towne Cable King wire rope electric hoist is a direct result of close collaboration between the staffs of Yale & Towne and Instrument Specialties Company. This is another typical example of the use of micro-processed beryllium copper to improve a product without increasing its cost.

BE CU^{mp} HAS LOWEST DRIFT OF ALL SPRING MATERIALS



When a spring is subjected to a steady load, its deflection gradually increases with time. This change is called "drift" (as distinguished from "creep" which is a similar phenomenon at elevated temperatures). Drift has a logarithmic relation with time, so that the drift measured for the first ten hours is equal to the drift for the next 100 hours, etc. With sufficiently sensitive short-time measurements (described in column at right) drift over a long-time interval may be estimated with fair accuracy. Such tests show that beryllium copper can be heat-treated to have lower drift than any other spring alloy—an important factor in any calibrated spring application.

I-S BRUSH SPRING TOLERANCES



Special coiling equipment developed at I-S for micro-processing beryllium copper, delivers brush springs to much closer tolerances than obtainable with ordinary coilers.

Standard Production Tolerances

Outside Diameter	
Up to ¼ in.	±.002
¼ to ½ in.	±.003
Load at specified length	±5 per cent
Number of coils	±½ (any length)

I-S coiling machines are also designed to cover a wide range of sizes.

Size Ranges

Wire Size (any coil diameter)	.072	max.
Coil Diameter (any wire size)	2.0	max.
Length (any wire size and coil diameter)	10.	max.

The two brush springs shown here were made on the same machine and were produced to the following specifications in large quantities.

	Small Spring	Large Spring
Wire Diameter	.0071 ± .0002	.0359 ± .0007
Coil Diameter	.079 ± .003	.577 ± .004
Test Length	.281 ± .015	1.240 ± .150
Test Load	1.25 oz.	1 lb. 5 oz.

FROM THE I-S LABORATORY

SET TEST DETERMINES SAFE WORKING LOADS OF FLAT SPRINGS

By conventional methods, the determination of safe working stresses in most flat springs is costly and time-consuming since design formulae are based on assumptions that seldom apply to an individual spring.

Two alternatives are open: to over-design; or to employ a short-time operating test which serves as an accurate basis for predicting long-time performance.

Obviously, the latter is preferable when, for example, it is required to test a spring designed to withstand one hundred million cycles, or, a spring required to hold a load for one year without set.

Several years of constant use at Instrument Specialties shows that set testing offers a rapid and highly accurate method of evaluating safe working loads. In this method a spring specimen is given a momentary load application and the set or failure to completely recover its initial free position is measured. With sufficiently sensitive measuring equipment, such as the Carson Electronic Micrometer, set is found to increase directly with load up to a critical stress, where further increases in load cause very rapid increases in set. Maximum safe load is then established in relationship to this critical stress.

If the load is maintained for a period of time, drift takes place, i.e., the deflection under load increases with time. After removing the load, recovery occurs at a slow rate. Set under momentary load is essentially permanent but some drift occurs even with a short load time. Under standardized test conditions, however, drift can be eliminated as a variable.

In practice, a spring specimen is mounted in the Electronic Micrometer, clamped in the same manner in which it will be used in service. The free position is measured, the spring deflected to load position, and held for ten seconds. Then the load is removed and the set measured. For springs requiring high endurance, the set should be less than ¼% of the load deflection. Safe limits for other service conditions may be higher depending on the function of the spring. Once the maximum set value is determined, this rapid test becomes an accurate non-destructive quality control method.

LITERATURE

"Beryllium Goes to War"—I-S has reprinted, by courtesy of Fisher Scientific Company, an interesting discussion of the advances made by beryllium copper during the war period. A copy will be sent gladly upon request.

METALS and ALLOYS

Engineering File Facts

NUMBER 78 (Continued) **STAINLESS STEELS—BASIC TYPES**

Group III—Austenitic

Chromium-nickel steels, containing a total of 24% or more of these metals, and not less than 6.0-8.0% of either. Not hardenable by heat treatment, but work-harden readily. They are extremely shock-resistant, difficultly machinable unless containing sulphur or selenium, can be hot-worked readily, and are capable of being cold-worked when due allowance is made for their rapid work-hardening. They can be welded without difficulty, but corrosion resistance may be impaired. While these steels show the best high-temperature strength of the stainless steels, and the best scaling resistance, they are subject to intercrystallar corrosion at temperatures from 800 to 1600 F. unless stabilized. Corrosion resistance is in general better than for martensitic or ferritic steels.

AISI Type No.	Composition				Annealing Temperature	Properties or Uses
	Carbon	Chromium	Nickel	Other Elements		
301	0.09-0.20	16.0-18.0	7.00-9.00	Mn 1.25 max.	1750-2050 F.	A general utility stainless steel, easily worked—for trim, household utensils, structural purposes
302	0.08-0.20	18.0-20.0	8.00-10.00	Mn 1.25 max.	1750-2050 F.	A readily fabricated stainless for decorative or corrosion resistant use
302B	over 0.08	18.0-20.0	8.00-10.00	Si 2.00-3.00 Mn 1.25 max.	1750-2050 F.	Silicon added to increase scaling resistance at high temperatures
303	0.20 max.	18.0-20.0	8.00-10.00	S or Se 0.07 min., or Mo 0.60 max.	1800-2050 F.	A free-machining grade "18-8" stainless steel
304	0.08 max.	18.0-20.0	8.00-10.00	Mn 2.00 max.	1750-2050 F.	A low-carbon "18-8" metal, weldable with less danger of intercrystallar corrosion
308	0.08 max.	19.0-22.0	10.00-12.00	Mn 2.00 max.	1750-2050 F.	For use when corrosion resistance greater than that of "18-8" metal is needed
309	0.20 max.	22.0-26.0	12.00-14.00		1850-2050 F.	For elevated temperature use, combining high scaling resistance and good strength
309S	0.08 max.	22.0-26.0	12.00-14.00		1850-2050 F.	Low carbon permits welded fabrication with a minimum of carbide precipitation
310	0.25 max.	24.0-26.0	19.0-21.0		1900-2100 F.	Similar to "25-12" stainless, with higher nickel content for greater ability at welding temperatures
316	0.10 max.	16.0-18.0	10.0-14.0	Mo 1.75-2.50	1850-2050 F.	Superior resistance to chemical corrosion
317	0.10 max.	18.0-20.0	14.0 max.	Mo 3.00-4.00	1950-2100 F.	Higher alloy content than 316 for increased corrosion resistance
321	0.10 max.	17.0-19.0	8.0-11.0	Ti min. 4 times C	1950-2050 F.	An "18-8" type stabilized against intercrystallar corrosion at elevated temperatures, etc.
347	0.10 max.	17.0-19.0	9.00-12.00	Cb 8 times C	1700-2000 F.	A stabilized "18-8" stainless for service at elevated temperatures, for welding, etc.

In addition to the AISI types shown, several other compositions recently dropped from the list are still manufactured in substantial quantity. These are no longer listed because they are replaceable by other types or were in little demand, or were reclassified elsewhere.

Of the martensitic steels, the 418 material, containing 2.50 to 3.50% W, was especially useful for high temperature uses. Alloy 439 was dropped from this classification because it is considered to be more properly classified with the tool steels. It contains 8.0 Cr and 8.0% W, and finds use where high heat strength is needed, as in diesel engine valves, or for seats of manually operated valves. A tungsten-bearing ferritic type, 438, was also discontinued.

The austenitic steels 311 and 312, the former 19.0 to 21.0 Cr, 24.0 to 26.0% Ni, the latter 27.0 to 31.0 Cr, 8.0 to 10.0% Ni, were high-alloy compositions for special purposes, and of limited utility. Several copper-bearing compositions, 315 and 325, were used for specialized corrosion resistance. Type 329, containing 25.0 to 30.0 Cr, 3.0 to 5.0 Ni, 1.0 to 1.5% Mo, is still made when high corrosion resistance and precipitation-hardening qualities are desired. When heated below annealing temperature and slow cooled, the composition is appreciably hardened. A high-stability composition, 330, with 14.0 to 16.0 Cr, 33.0 to 36.0% Ni, is still used for carburizing boxes, etc.

Compiled by Kenneth Rose, Engineering Editor

"Wartimes"
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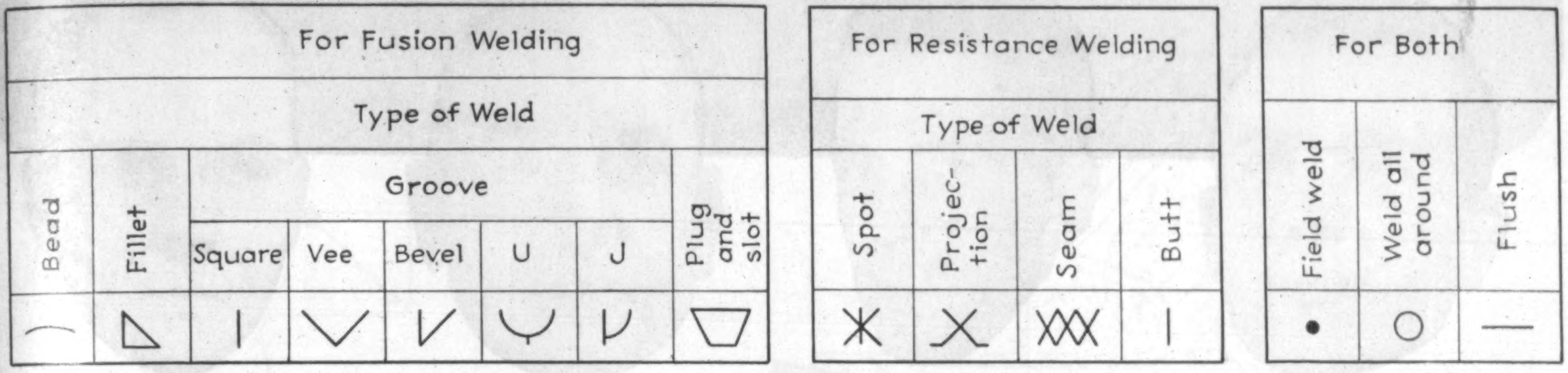
NUMBER 79
April, 1945

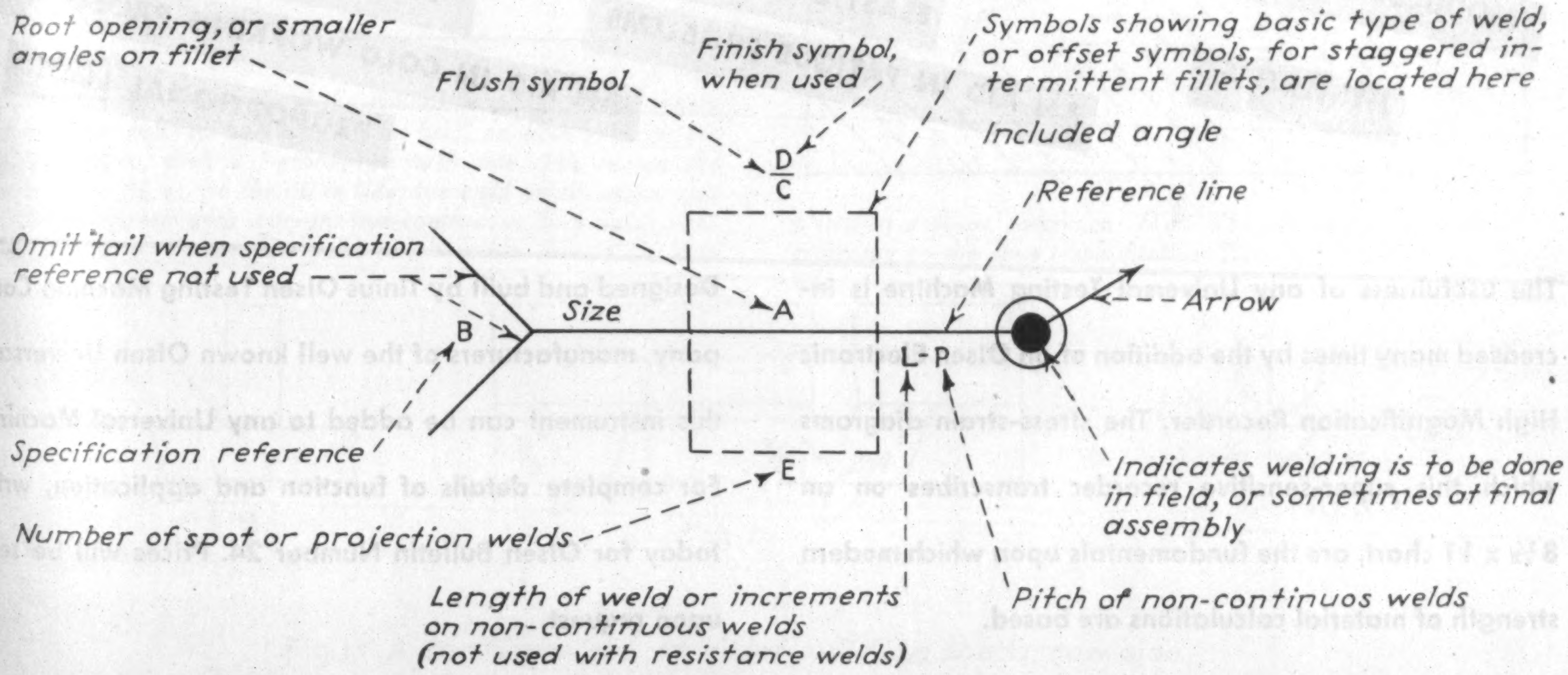
METHODS AND PROCESSES
Welding

Welding Symbols

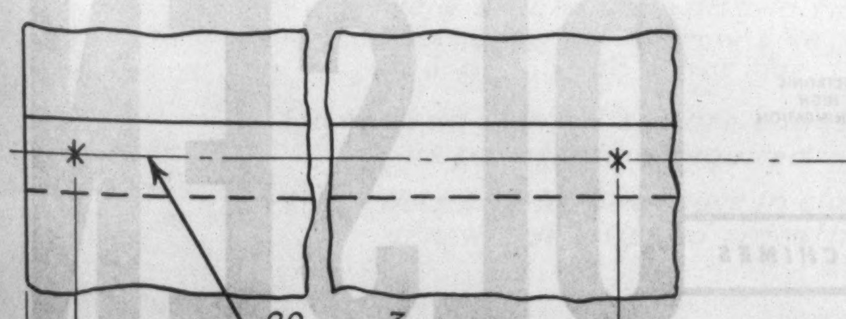
In the welding symbol the reference line indicates the weld location. It is placed beside the joint, not in line with it. The arrow connects the reference line to the center line of the weld, or to the grooved member, or to the arrow side (near side) of the weld in section or end views.

Symbols below the reference line refer to the arrow side (near side) of the weld; those above it to the other side (far side). Those symbols having a perpendicular leg are always drawn with this leg to the left-hand side. Both-sides welds, when of the same type, are of the same size unless otherwise noted. When the symbol has a perpendicular leg, the size is placed on the left hand of the symbol.

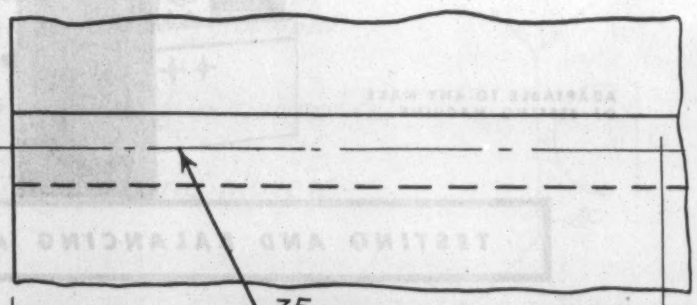

For Fusion Welding
Type of Weld
Bead
Fillet
Groove
Square
Vee
Bevel
U
J
Plug and slot
For Resistance Welding
Type of Weld
Spot
Projection
Seam
Butt
For Both
Field weld
Weld all around
Flush


Root opening, or smaller angles on fillet
Flush symbol
Finish symbol, when used
Symbols showing basic type of weld, or offset symbols, for staggered intermittent fillets, are located here
Included angle
D
C
Reference line
Omit tail when specification reference not used
A
Arrow
Size
B
L
P
Specification reference
E
Indicates welding is to be done in field, or sometimes at final assembly
Number of spot or projection welds
Length of weld or increments on non-continuous welds (not used with resistance welds)
Pitch of non-continuos welds

The symbols indicate a series of spot welds, starting 2 in. from the end of piece and continuing for 1 ft. 6 in., to be made on 3-in. centers, and to possess a strength of 2000 lb. each.



The second portion shows the symbolic representation of a seam weld, 9 in. long, the arrow side to be welded flush, and the seam to have a strength of 3500 lb. per linear in.



(Continued on page 1039)

TENSILE STRENGTH and % ELONGATION IS NOT ENOUGH . . .

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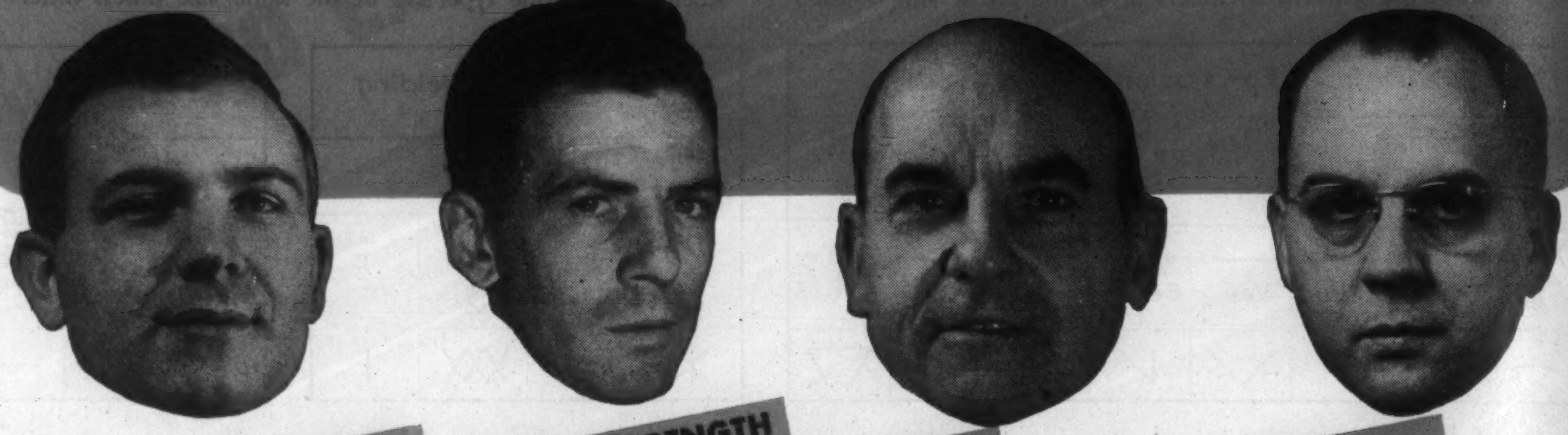

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HYSTERESIS

YIELD STRENGTH

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AN AID IN COLD WORKING PROBLEMS

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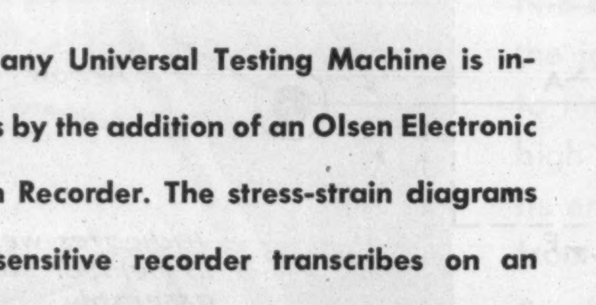

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METALS and ALLOYS

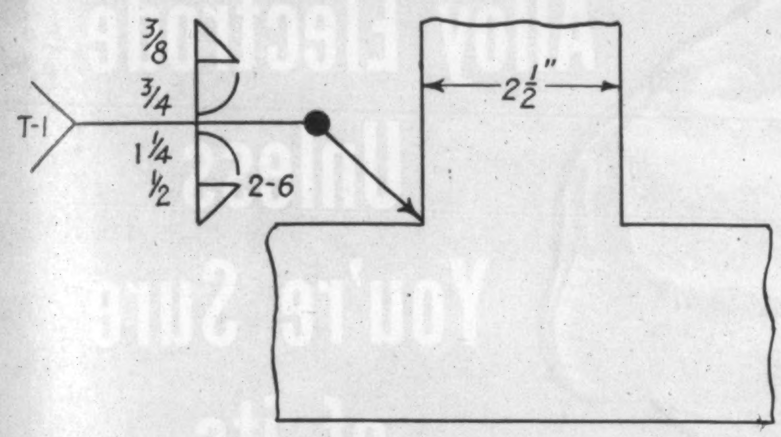
Engineering File Facts

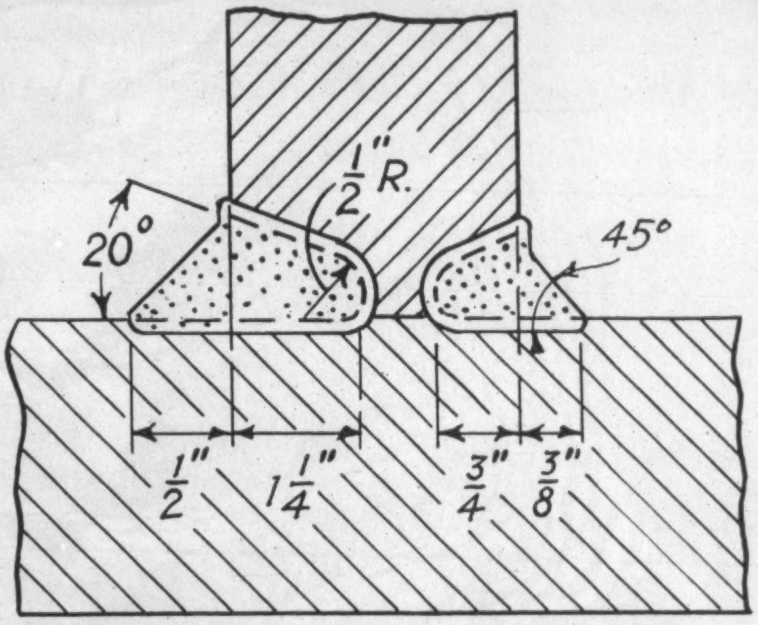
Resistance welding symbols for spot or seam welds are centered on the reference line, because they have no arrow side and other side. Projection welding symbols are not centered, as they show differences. Since it is not practicable to determine sizes in resistance welding, strength of the weld is substituted for this value. Strength is given in units of 100 lb. per weld for spot or projection welds, 100 lb. per linear in. for seam or butt welds, and 100 lb. per sq. in. for welds made all around.

Symbols for spot or seam welding may be placed directly on the lines of the drawing, rather than on the reference line of the welding symbol. Projection weld symbols are not so used.

When welds are to be finished, the following code is suggested for finish symbols: C—chip; G—grind; M—machine.

For special welds that cannot be shown by any of the above symbols, a detailed drawing should be made, and reference made to it in the welding symbol.





As examples of the use of the symbols, the designation shown indicates a weld to be made in the field, on both sides of the vertical plate, with a J-groove on each side, 1¼ in. on the arrow side, ¾ in. on the other side; the weld on the arrow side to be completed with a ½-in. non-continuous fillet weld, 2 in. long, 6 in. on center; the weld on the other side to be completed by a ⅜-in. continuous fillet. The welding is to be done according to the shop's specification T-1.

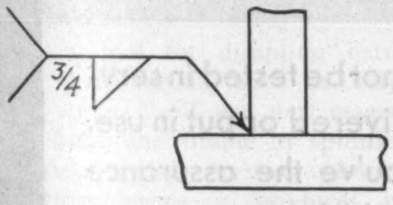


Fig. 1

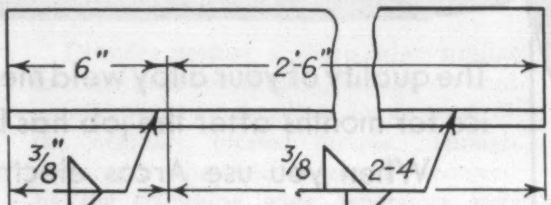


Fig. 2

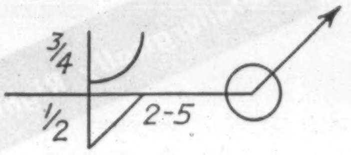


Fig. 3

- Fig. 1 - A continuous $\frac{3}{4}$-in. fillet weld on the arrow side
- Fig. 2 - Fillet welded $\frac{3}{8}$ in. both sides, the first continuous 6 in., the second intermittent welded with staggered 2-in. welds on 4-in. centers
- Fig. 3 - Weld all around with $\frac{1}{2}$-in. fillet welds 2 in. long on 5-in. centers on arrow side, continuous $\frac{3}{4}$-in. weld in J-groove on other side
- Fig. 4 - Bead joining square edges on plates, $\frac{1}{8}$-in. clearance, $\frac{1}{4}$-in. penetration required
- Fig. 5 - Weld in $\frac{7}{8}$-in. U-groove in closely abutting plates, arrow side chipped smooth

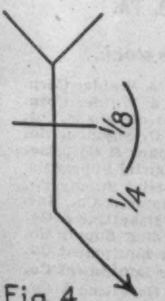


Fig. 4

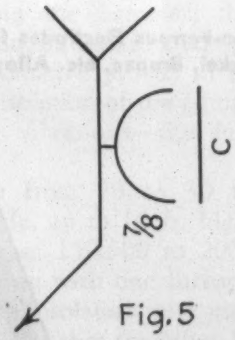
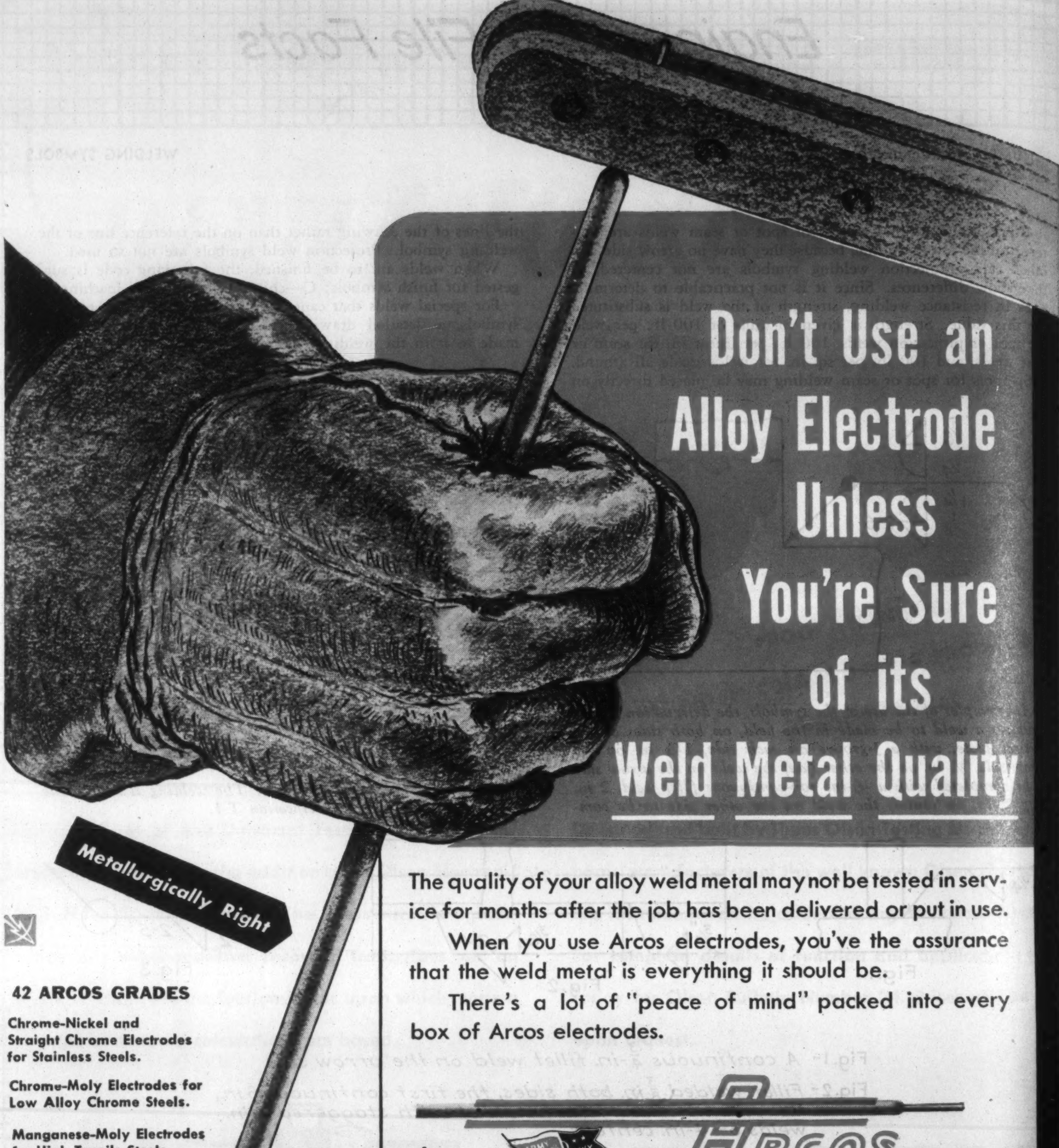


Fig. 5

Based upon an American Welding Society Standard



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Metallurgically Right

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engineering SHOP NOTES

Spin Dimpler for Brittle Sheet

by Herman Veit,
Glenn L. Martin Co.

A new tool for dimpling hard and brittle sheet metals, such as Reynolds 301-T, Alcoa 75-ST and new magnesium alloys, forms the dimple by spinning the metal rather than by pressing it into shape. In certain metals it produces perfect dimples in 2 to 5 sec. per dimple; with other metals, from 5 to 9 sec. per dimple.

It has been used on a single spindle Allen drill press, but is equally adaptable to any drill press supplying 1500 r.p.m. rotation.

Dimples feature a sharp edge similar to a machine countersink, leaving no void around the rivet head, as in the case of the ordinary pressed dimple. Though cladding of the sheet is partially removed by the trimming edge, laboratory tests show that the spun dimple resists corrosion as well as a machine countersunk hole.

Exact centering of the dimple is assured by a tip on the spinning tool exactly fitting the inside diameter of the rivet hole. Lubricant is used with aluminum alloys, but omitted with magnesium alloys.

The dimpler consists mainly of four parts; a female die, similar to that used with a pressure pad dimpler, into which the metal is spun; a male spinning tool, a trimmer cutting edge to remove any metal that is extruded upward during the forming of the dimple; and tool, a pressure pad assembly for holding the sheet in place during dimpling. The spinning tool, itself, has several projections that are rounded off to eliminate machining of the metal from the inside of the dimple. To permit easy replacement, it screws into the pressure pad assembly shaft.

The dimpler has been used at the Martin plant to form 100 deg. dimples for $^3/_{32}$, $^1/_8$, $^5/_{32}$ and $^3/_{16}$ in. diam. rivets in both aluminum and magnesium alloys varying from 0.020 to 0.064 in. thickness. In the case of aluminum Tycol-655 was used as a lubricant.

The accompanying photo presents the author, designer, the dimpler and its product.

Protecting Furnaces Against Vibration

by R. L. Booth,
The Korfund Co.

Arches of furnaces adjacent to a battery of forging hammers in a drop forging plant were collapsing after three months of operation. It was considered impractical to use the positive vibration control method of mounting the hammer, the source of the vibration, on isolating equipment. The only alternative proved to be negative control, or isolation of the equipment receiving the vibrations—the furnaces.

The furnaces are from 20 to 30 ft. long, 8 or 10 ft. wide, up to 10 ft. high, weighing, loaded, from 150,000 to 200,000 lb. Experimenting with one furnace, heavy duty steel spring isolators were used and proved so successful that the other 16 furnaces were likewise handled.

The vibration control was designed and manufactured by the Korfund Co., Inc., Long Island City. N. Y.

Temperature of Steel in Furnace

by L. F. Weitzenkorn & G. C. Klingel,
Rustless Iron & Steel Corp.

By improving on a British device, there has been put to use a platinum thermocouple pyrometer that measures the temperature of a steel bath before the heat is tapped from the melting furnace, the reading being recorded by an electronic instrument. Its predecessor, the optical pyrometer, measured temperature only when the liquid steel was visible in the open and being poured. With the new Rustless device, the temperature of the steel can be measured even when covered with a layer of slag—and at a time when steps can be taken to control the temperature.

Hitherto measurement of molten steel has depended almost entirely upon the experienced eye of the melter, judging the appearance of a small sample of molten metal withdrawn from the furnace. The pyrometer consists of two interchangeable parts, an immersion head (a platinum and platinum-rhodium thermocouple encased in a fused silica tube mounted in a block of graphite), and a handle that is a 12-ft. insulated pipe containing the wires leading to an electronic recorder.

The operator immerses the exposed tip of the silica tube into the bath. The whole operation, automatically recorded, takes 45 sec. The instrument is equipped with a large pointer and dial calibrated in degrees Fahrenheit. One can operate in temperatures up to 3200 F. The key to its success is its high speed. With ordinary exposures most materials would soften or be destroyed.

Individual readings cost a little over $1 each. The design and operation are such that the platinum wire and other materials are not destroyed.

Speedy Repairing of Cupola

by David Sanner,
Cooper-Bessemer Corp.

A new windbox section was needed for the foundry's cupola at the Mt. Vernon, Ohio plant of Cooper-Bessemer. The foundry was in the midst of critical war production, and when the cupola was down, all castings production ceased. To make a long story short, a new windbox was installed, with loss of only a single day's operation. The key to this speed was careful preplanning and placing of all raw materials and handling equipment at the site of this major operation.

The last pour was of 53 tons on a Friday afternoon. The old lining was removed Friday night and shoring-up began early Saturday. Steel H-beams were placed upright under the charging floor and wedged securely to hold the top part of the stack in place. A crane-hook was attached to the bottom-ring to hold it in position while legs were removed. Then the bottom-ring was cut loose from the windbox, lowered to the foundry floor, and dragged away by a main floor crane. The charging crane was re-hooked to the old stack and cribbing installed underneath to guard against any swing or twist when the stack was cut loose. After detaching the old windbox, it was lowered to greased rails and taken away by block and cable.

The new windbox was then slid under the charging floor by the same method, raised into position and held there by cribbing until partially welded. Following this the bottom ring was properly placed and all sections finish welded. During this operation the old sandstone foundation was cleared off and a heavy steel frame set on a foundation to level up.

The grouting was then poured using "High Early" strength cement in the mix. Legs were set and secured by bolts and welding. After covering the grouting for protection, lining-up started while millwrights and electricians completed their work. Molten metal was run off a charge of 46 tons on Monday afternoon, with a loss of only one day's operation.

Quick Testing Stresses in High Temp Metals

by R. P. Toolin,
Westinghouse Electric & Mfg. Co.

New high temperature alloys used in steam turbines, jet propulsion units and other high temperature machines can be tested for endurance limits in a month, whereas it would take five or six years to test in actual operation. This short cut testing is accomplished on a special machine developed by Westinghouse research engineers.

At room temperature, the story of endurance of a metal is usually told in ten million cycles of stress. But, at elevated temperatures, the curve of waning endurance continues downward for several hundred million cycles. By ordinary means, it takes years to stress an alloy sample held at, say, 1500 F. a quarter of a billion times.

The special machines can do this testing job in a month. The test piece is clamped in a furnace that maintains the desired temperature. Through the clamping structure is applied a stress 120 times per sec. by two stator coils connected to a two-phase 60-cycle supply line. The entire system is mechanically tuned to resonance at this frequency to minimize the driving force necessary.

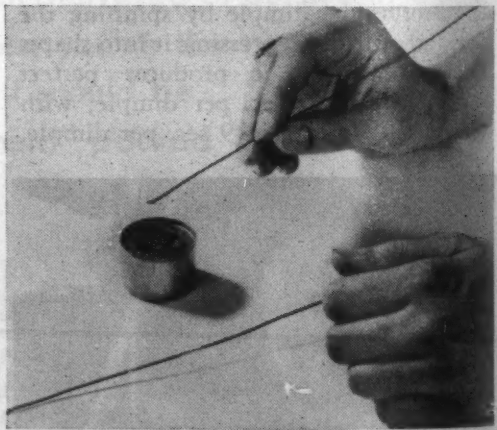
This tuning also serves another highly desirable purpose. Research engineers want to see the specimen after the first tiny crack occurs, not after the complete failure of the sample. With this device, the first crack reduces the stiffness of the system, which detunes the mechanism to such an extent that the machine automatically stops.

Thus, a sample can be placed in the tester, heated to the desired temperature and the test started and allowed to run day and night without attention for weeks or months until failure just begins, after which the test stops itself without continuing until important evidence of the mechanism of failure is destroyed. Tests of high-temperature alloys up to a billion applications of stress have been made in 100 days.

Economical Brazing of Wires

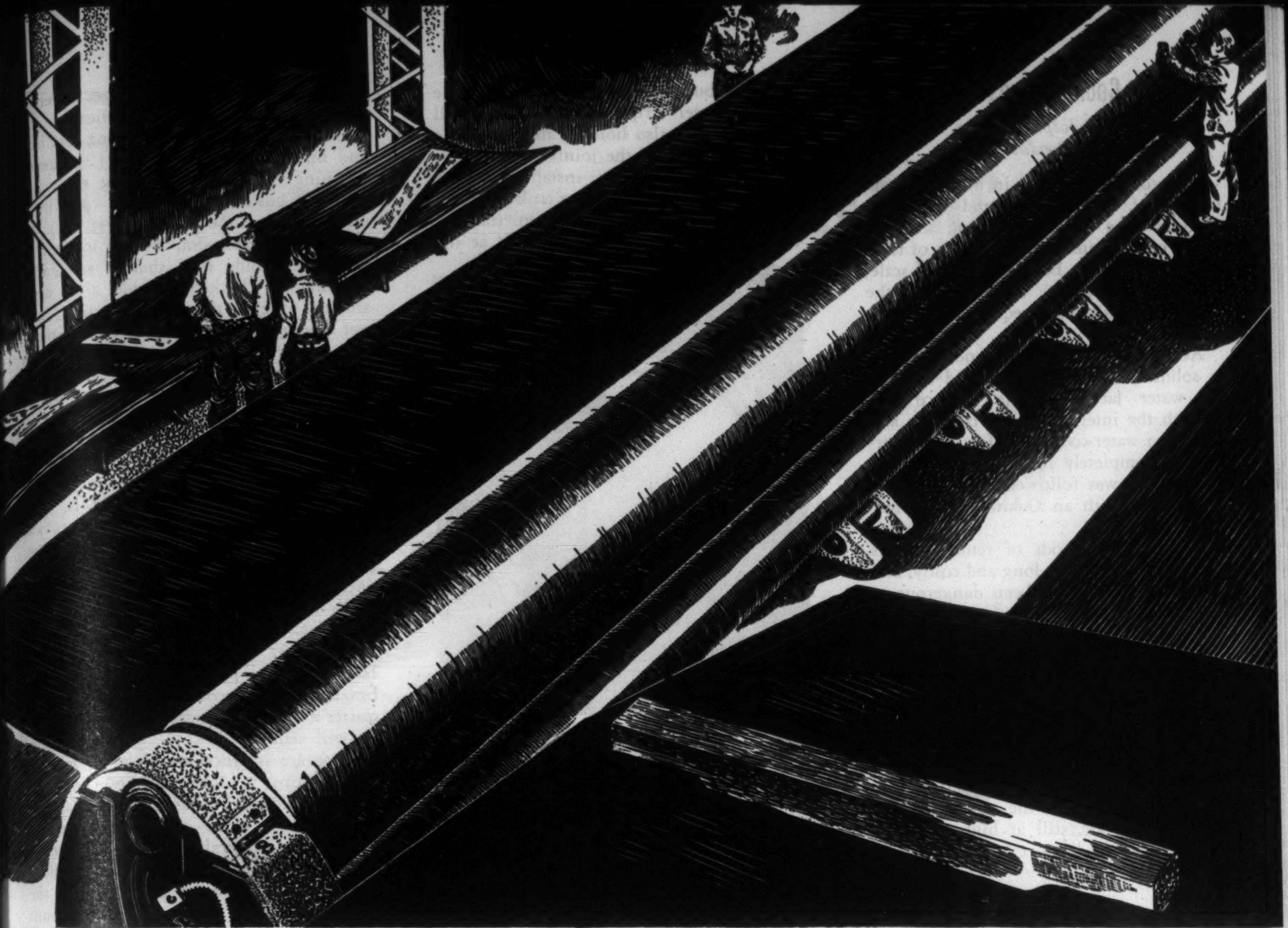
by W. J. Curry,
General Electric Co.

A new method of brazing small round wires, 0.0226 to 0.049 in. diam., has been adopted in this Schenectady plant, resulting in saving of 80% of the strip silver alloy. In the conventional method of brazing these small wires, a strip silver alloy and flux are used, resulting in a loss of the silver, both from drip at the braze and excess of brazing material at the point of contact.



But now—the end of one of the two wires is either moistened or heated and then inserted in the container holding a mixture of equal amounts of filed silver solder and borax flux. When a sufficient amount adheres to the wire, the two ends are placed together and heated over a gas flame until the alloy fuses them.

If normal heating is applied, the joint will be free of lumps and points, eliminating a finishing operation before the braze can be insulated.



Hatching a HEAVYWEIGHT

...Huge Plate Roll Fabricated By Thermit Welding

You're looking at a large bending roll that functions above two smaller bottom rolls as a unit for forming steel plate. Fabricating this heavyweight roll threatened for a time to be a major difficulty. Few foundries were available that could make a single casting of the required size: 38 feet long by 31½ inches in diameter and 50 tons in weight. The problem was solved by making two castings of about 25 tons each and uniting them by Thermit welding.

It's Thermit welding's ready adaptability for such heavy tonnage jobs that makes it so suitable a process for both fabrication and repair of large castings and forgings.

Thermit welding joins smaller parts into large units to save time, money, shipping and handling problems. There's no limit to the size of a Thermit weld—no need for pre-heating or stress-relieving—no need to worry about the strength or permanence of the weld, for it's as strong as a forging of the same cross-section. And Thermit welding can be done in your own plant, by your own crew, under M&T supervison, or at the following Metal & Thermit Corporation Branches: Jersey City, New Jersey; Chicago, Illinois; Pittsburgh, Pennsylvania; or South San Francisco, California.

Thermit Welding

Descaling Cooling Pipes of Furnaces

by Rudolph L. Fiske,
Oakite Products, Inc.

One concern engaged in the bright annealing of steel tubes found that scale deposits were greatly lessening the efficiency of the water cooling system of their annealing furnace. Besides, pieces of scale, loose in the system, were clogging the pumps, necessitating frequent shutdowns and adjustments.

At length Oakite compound, No. 32, in solution form, was circulated through the water jacket of the furnace and through the interiors of the bearings and rolls, also water-cooled. A few hours' circulation completely removed all scale deposits. This was followed by rinsing and neutralizing with an Oakite alkaline material.

Mechanical methods of removing this scale would have been long and costly, and raw acids would have been dangerous to handle and harmful to equipment.

It will be recalled that in bright annealing the steel must be cooled (after annealing at 1400 to 1650 F.) in an oxygen-free atmosphere, so it is held in a special cooling chamber, charged with dry nitrogen or hydrogen. Heat is carried away from the cooling chamber by a water cooling system. If the latter does not function properly, the steel will pass into the open air, still at high temperatures, the surface liable to oxidize.

In drawing steel cartridge cases, what appeared to be one of the best lubricants was a soap film on the draw piece, states Lt.-Col. Harold R. Turner, authority on steel shell manufacture. Soap was adopted by over 50% of the manufacturers. The requirement was that a uniform and continuous film of dried soap be present over the case, both inside and out, to provide lubrication both for the punch and the draw die. Some used the soap with a light oil, since water destroyed the effectiveness of the soap.

—American Soap & Glycerine Producers

Lining Tanks with Stainless Steel

by Randolph Mockbee,
(Courtesy of Hobart Brothers Co.)

Stainless steel is used widely for lining tanks in the chemical industry, in restaurants, etc. where corrosion of contained fluids is to be guarded against. It is something of a trick to line an old tank with this wonder steel. Here is a bit of practical "know how" involving a large steam jacketed cooker that had become badly rusted and was discoloring the contents.

It was decided to install a 16-gage stainless steel lining with electric arc welding and stainless steel electrodes. To insure minimum loss of heat transfer, the lining was placed in 12-in. strips and tightly expanded against the inner face of the tank with two ¼-in. steel bands, equipped with turnbuckles. The bands clamped the stainless steel strips snugly to the wall of the cooker, also holding them in place during welding of the joints.

As each strip was installed it was bonded to the inside of the tank by welding along the edges with ⅛-in. stainless steel electrodes. Any open spaces at the seams were completely filled in with the electrodes. The cooker has been in service since the new lining was applied for a long time and is satisfactory. Though the heat transfer rate has been cut 20%, this has not hampered the process, and the same steam pressure as before is being used on the cooker.

The photo shows two adjustable expanding bands holding the stainless steel in place while being welded.

Stellite thread plug gages have given 5 to 20 times longer service than previous steel gages, according to a study made by the Cadillac Gage Co., Detroit. The study was made in the plants of armament manufacturers in gaging of precision parts made of materials varying in abrasive qualities. Actual gage costs are reduced 50 to 85%. Because Stellite is an alloy of cobalt, chromium and tungsten, it is superior to steel for inspection tools. It has a low coefficient of friction, resists wear, is acid- and corrosion-proof, and is non-magnetic.

—Rolfe C. Spinning, Detroit

Cast Iron Base for Carbide Tipped Tools

by Ed C. Powers,
Cooper-Bessemer Corp.

Meehanite cast metal was first used as a base for carbide-tipped single purpose tools by the Cooper-Bessemer Corp. because of the inability to get the proper steel in the early phases of the war. After tests, a suitable grade of Meehanite was developed and used for the conventional single purpose cutting tools tipped with carbide. But what was first considered an emergency use was soon found to be a "natural."

Among important advantages Meehanite has over steel for this application are: (1) Casting to shape, requiring less time and machining to complete; (2) greater damping capacity, eliminating tool chatter; (3) easier machining of tool, using one-half the time and power; (4) coefficient of expansion nearer to that of tungsten carbide than that of steel, thus eliminating checked carbide tips when affixing, due to unequal expansion; (5) not loading up grinding wheel as rapidly, with resulting grinding economy; and (6) ability to dissipate heat at a faster rate, hence cooler operation and longer tip life.

During the first year of this Meehanite application, over 800 tons were used for single-purpose tool shanks by several hun-application to other cutting tools, such dred manufacturers. The next step was as forming tools and milling cutter bodies. Meehanite bodies may go hand in hand with higher cutting speeds in milling.

To fasten the Meehanite bodies to the tool tips, a silver solder, such as "Easy-Flo No. 3," is good. Since Meehanite has a melting point of 2350 F., copper brazing is not recommended, since it requires a higher temperature than Meehanite will stand.

Here are instructions for torch brazing carbide tips to Meehanite bodies: (1) Mill the necessary recesses to suit the type of tip; (2) clean all joining surfaces thoroughly, preferably with carbon tetrachloride; (3) cut a piece of silver solder to conform to the sides and bottom of the carbide tip; (4) apply a liberal amount of flux (such as Handy) in the recess; place the solder in the recess and cover with flux; after grinding, tip on the side and edge where it is to be brazed to the tool, lay carbide tip in place; (5) heat bottom of tool directly underneath the recess, keeping the flame of the torch ¼ to ½ in. away from the work; gradually heat the sides, joint and tip until the solder flows freely, wetting the carbide tip; press tip into recess with a steel rod; keep temperature under 1300 F., the shank becoming cherry red at the right temperature; (6) bury tool in asbestos, mica or lime for cooling; and (7) when grinding, remember that a razor edge on the tip will cause the tool to break; hone the razor edge with a fine hone to 0.005-in. radius on the edge, thus making the tip last longer.

When quantity brazing is justified, the heat is obtained by induction with a high frequency electric motor generator set, high frequency electronic equipment, or a gas heated furnace.

A simple way to repair cracked molds in the brass mill cast shop of Western Cartridge Co. was devised by George Handler and Jesse Duncan. A trench is cut directly behind the cracked spot and a copper rod is laid in it. Then the copper rod is peened in such a way as to fill up the crack. This method has saved many thousands of pounds of pure copper.

—Labor and Management News, Dec. 2, 1944.

Metal-Working Industries

ENGINEERING DIGEST

A selection of outstanding articles on engineering materials and processing methods

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Metals and Alloys

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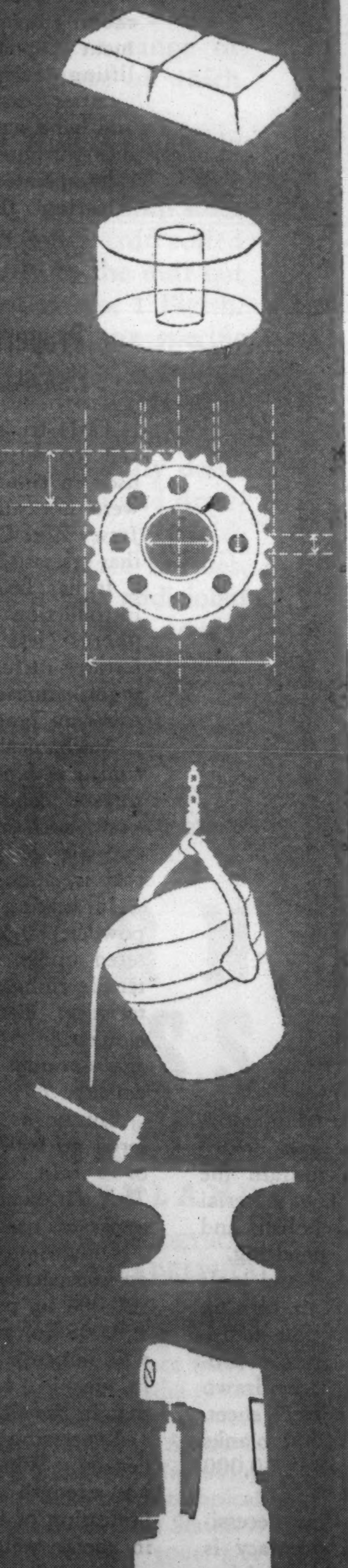

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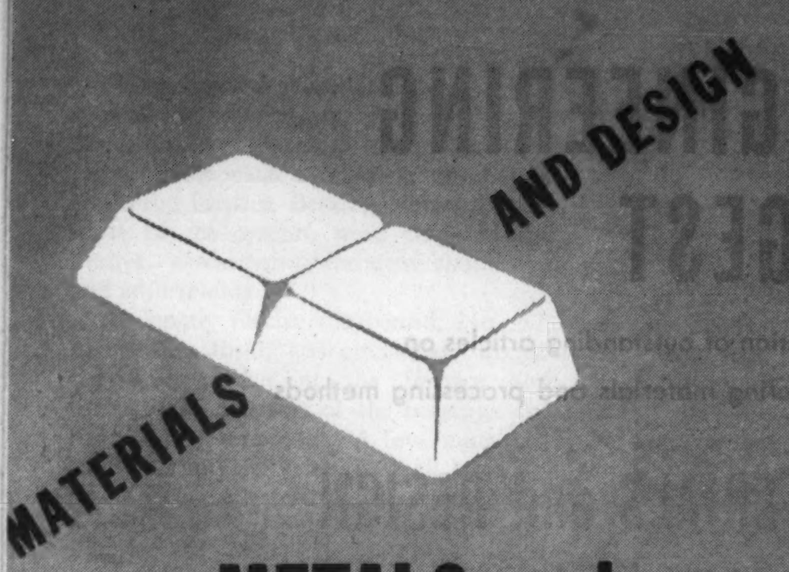

METALS and ALLOYS

Engineering properties and applications of carbon, alloy and stainless steels, irons and nonferrous metals and alloys. Selection and evaluation of metallic materials for engineering service. New alloys and modifications.

Zinc Alloy Dies

Condensed from "Steel"

Kirksite is a zinc-base alloy containing aluminum, copper and magnesium. It is a modification of a die-casting alloy, based on the sacrifice of fluidity in the interest of improved physical properties. In a sand casting, Kirksite has about 20% higher tensile strength and 20 points higher Brinell hardness than die casting alloys in a sand-cast condition.

This material casts in sand with great fidelity of detail and accuracy of dimension. Castings have physical properties not far below those of mild steel, and shrink about the same as cast-iron. They are hard enough to resist wear for long periods, yet are soft enough not to scratch any of the sheet-metals, including Alclad.

The service life of these dies is considerably greater when they are used in modern presses of double-acting type, which provide for pressure pads to restrain the sheet-metal from wrinkling. The material is easy to machine, weld, and polish, and loses none of its properties in remelting.

Work so far indicates that dies and tools of this alloy will prove useful in turning out experimental and low-production stampings. Kirksite has been used in the production of as many as 25,000 deep-drawn stampings from 0.024-in.-thick steel sheet. One set of dies has produced 1000 blanks of 0.050-in. stainless steel and 30,000 blanks of 0.062-in. duralumin.

Extreme accuracy of these dies necessitates some hand work. Their accuracy is controlled almost entirely by the precision of the patterns from which they are cast. In general, the more intricate the shape, the greater the savings on die costs. When surfaces of double curvature are to be produced, the cost of Kirksite dies is from 5 to 30% of the cost of conventional dies.

It is estimated that about $10,000 would enable the average stamping company to install equipment to make these dies. Necessary equipment includes marble- or stainless steel-top tables for the plaster work; metal saws for producing pattern templates; mechanical mixers for plaster; a supply of inexpensive hand tools; and a cast-iron melting furnace. Flasks, conditioning equipment (optional), and adequate overhead lifting devices complete the set-up.

After castings, flexible shaft grinders and hand scrapers are needed to prepare the dies for the stamping press. An hydraulically-operated fitting bench is desirable in "clearing" the dies.

—*Steel*, Vol. 115, Nov. 20, 1944, pp. 114, 158, 160.

Properties of Brass Powders

Condensed from "The Iron Age"

Early trials of brass powder by commercial concerns indicated that atmospheres used in sintering iron and copper powders were not suitable. Investigations by New Jersey Zinc Co. revealed several atmospheres that are satisfactory.

It has been found that the mechanical introduction of a small amount of phosphorus (less than 1%) as phosphor-copper powder increases elongation, decreases optimum sintering temperature and broadens sintering range.

Mechanical properties of sintered brass compacts depends on particle size, shape and surface condition; on compacting conditions, such as pressure, speed, lubrication, and die design; and on sintering control, that is, atmosphere, temperature and time.

In making tests, it was found that brass powder, 70-30 (with phosphorus), if sintered under conditions yielding maximum tensile elongation, has the following characteristics: Tensile strength, 38,600 p.s.i.; elongation, 55%; weight loss, 1.2%; shrinkage (normal to compression), 1.2%; and density, 7.79 gm. per cc.

Specimens sintered 15 or 30 min. blistered at 1607 F., while those sintered 0.1 or 5 min. did not blister until 1652 F. This difference may indicate some lag in apparatus used for determining temperature.

Dimensional tolerances to be expected on compacts as sintered are: On diameter, ±0.004 in. per in.; in direction of pressing, ±0.008 in. per in. Repressing or coining will improve diameter tolerance to 0.0005 in. per in., but probably will not change that in the direction of pressing.

Repressing may be used also to increase density. When neither maximum density nor strength and ductility are needed, simplification of fabrication and some economy in metal weight can be realized through compacting at lower pressures.

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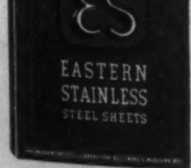

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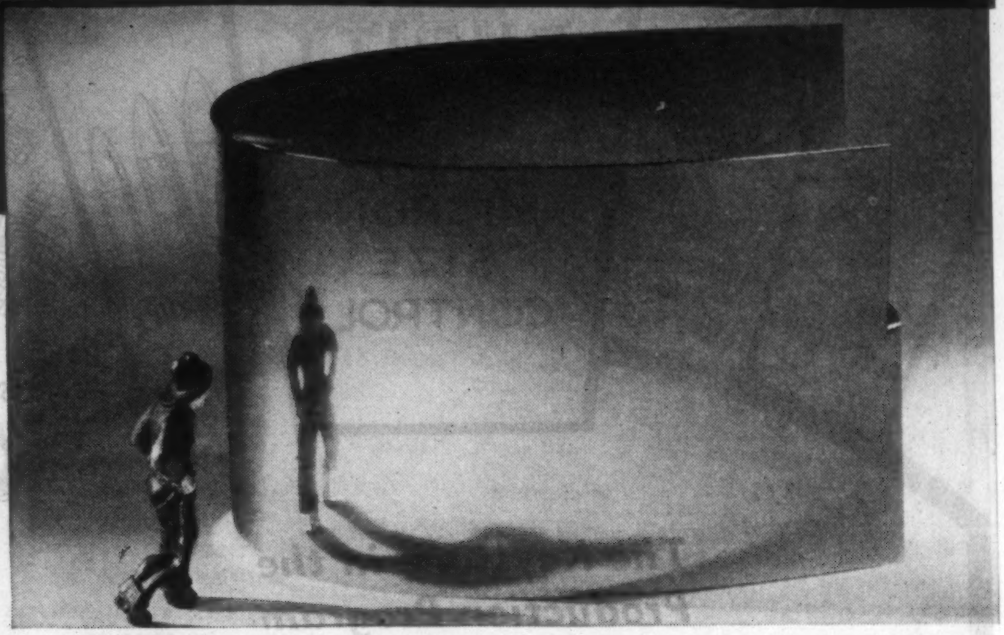
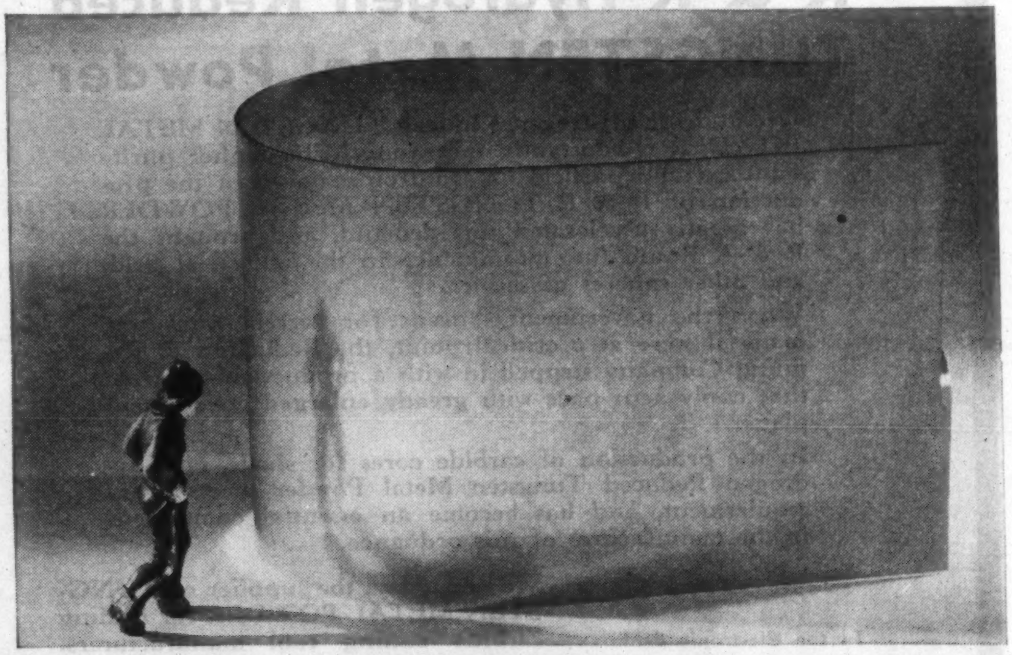
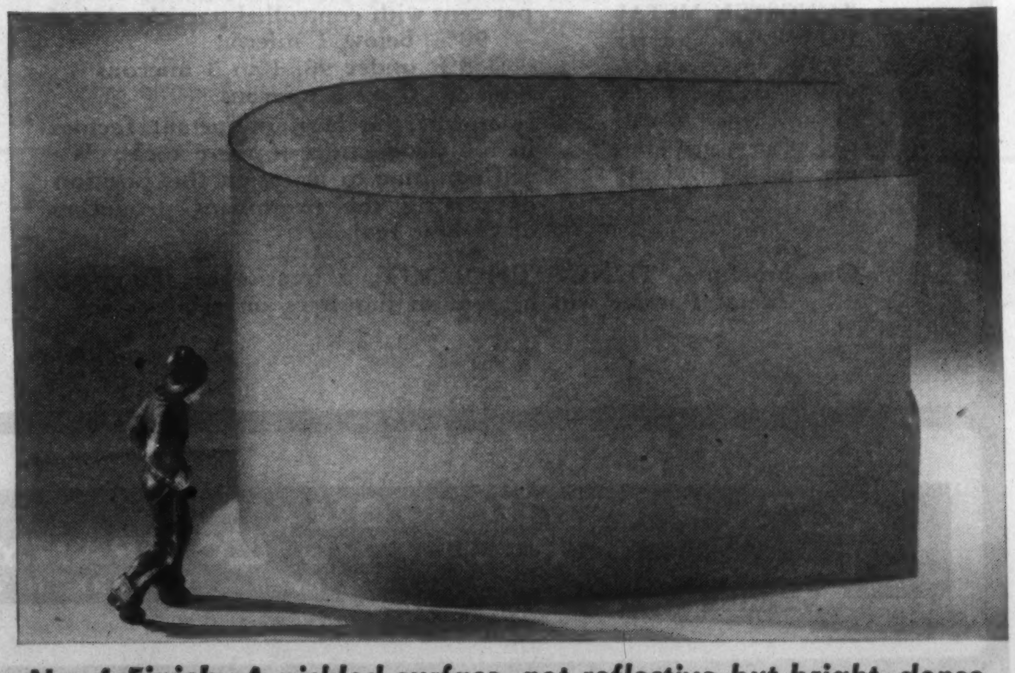


No. 4 Finish—Highly reflective, possesses a silvery appearance.



No. 2B Finish—Is mildly reflective, dense, bright and lustrous.



No. 1 Finish—A pickled surface, not reflective but bright, dense.

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Brass powder compacts in order to have sufficient green strength to be handled should be pressed at 25 tons per sq. in. Most powders have a compression ratio of 2.5 to 1. Press strokes rarely exceed 8 in., except in hydraulic machines.

Decision to use brass powder must be based on one or both of two factors—economy, and some unique feature of brass powder metallurgy that permits the solution of a particular problem.

—*Iron Age*, Vol. 155, Jan. 25, 1945, pp. 60-62.

Temper Rolled Tin Plate

Condensed from "Blast Furnace and Steel Plant"

Temper rolling of tin plate is not new in this country. It became desirable to temper roll sheet steel in coil form following the development of the strip mill. However, during recent years the can manufacturers have required greater temper hardness of tin plate, and at the same time have asked for a satisfactory ductility to permit fabrication.

To meet these requirements, temper pass mills have been built heavier and stronger to withstand rolling loads. The loads for temper rolling of the strip are sometimes heavier than those in the cold reduction of the strip from the hot rolled gage down to the required gage before temper rolling.

This cold reduced strip is used in tin plate, auto body sheets, furniture stock, and similar articles. Stainless steel panels are also produced by temper rolling.

The Unitemper Mill, announced by United Engineering & Foundry Co., was developed to meet the need for this grade of stock. It has been in experimental run at Republic Steel Corp., Niles, Ohio, for two years. The mill, apparently a conventional 4-high mill, is actually two independent 2-high mills, one mounted above the other.

By regulating the speed differential between the upper and the lower mill, the strip is continuously stretched between the two mills to the extent necessary to obtain the desired temper, hardness, and ductility. It also produces a very flat product.

The mill now in operation was designed for a top speed of 3000 f.p.m., and is now being operated at an average speed of about 2500 f.p.m. It has been found capable of producing all hardnesses up to T-5 from one grade of rimming steel, and in one pass through the mill.

—M. D. Stone, *Blast Furnace & Steel Plant*, Vol. 32, Dec. 1944, pp. 1457-1459.

Zinc and Zinc Alloys

Condensed from "Metallurgia"

Zinc's contribution to the war effort must remain to a considerable extent secret. However, some of its uses may be discussed. A large amount is being used in brass for munitions.

Zinc sheet is now being used almost exclusively for battery cans formed either by

(Continued on page 1056)

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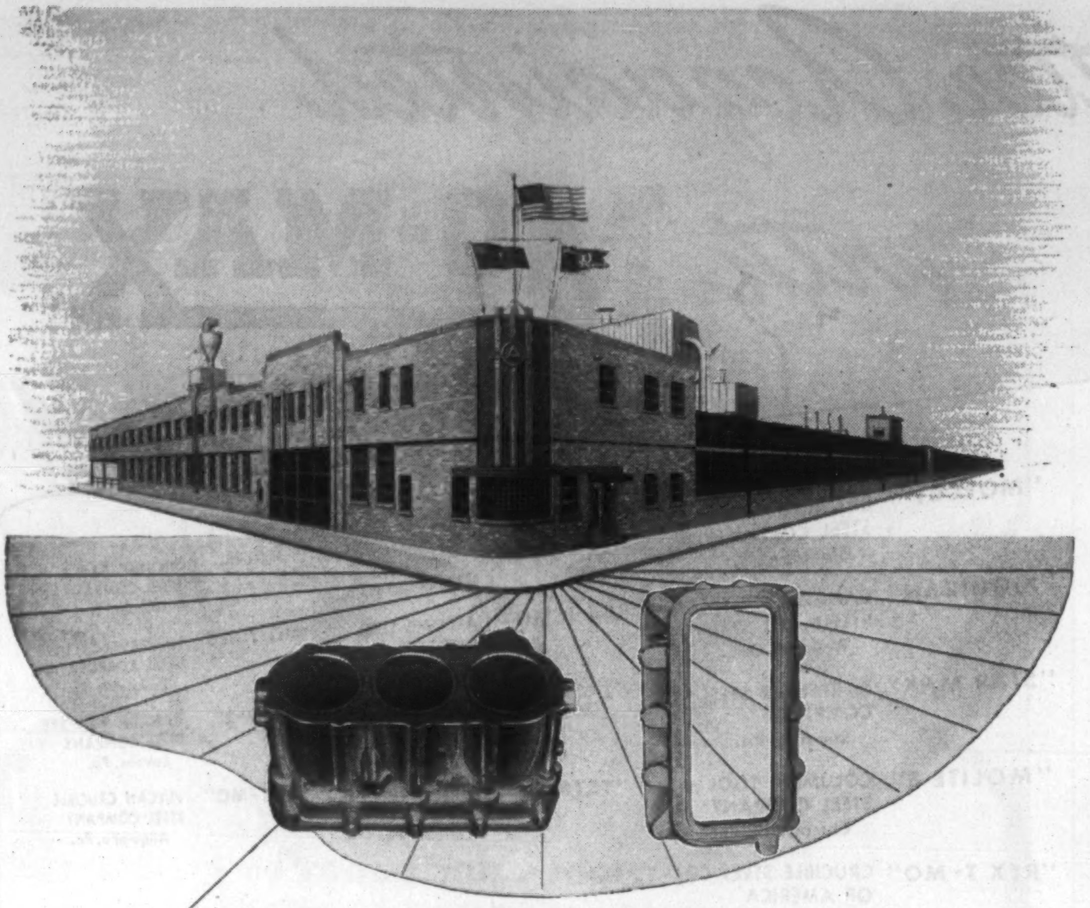

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impact extrusion or soldering. A small amount is used in the radio industry for condenser vanes and shielding devices. Commercial zinc can be rolled to 0.009 mm, while high purity zinc with a small amount of manganese can be rolled to 0.004 mm and even thinner. Earlier in the war, such foil was used for cigarette wrapping, wine bottle capsules, etc.

Zinc foil is stronger than aluminum foil of the same thickness but does tend to tarnish in the high temperature humidity test so it would have to be lacquered for use in the tropics. Although zinc sheet for roofing has been discontinued for the duration, an appreciable increase in the sheet zinc for postwar housing is anticipated.

Although the galvanizing of corrugated iron sheet has been suspended for the duration, zinc plating, sherardizing, and sprayed zinc are being used for protective purposes. A large amount of zinc has been used to protect ship hulls and boilers.

One of the two most spectacular developments in this field in the present war has been the use of pressure die castings. A government specification covers high purity zinc, a high purity alloy with 4 Al and 0.03% Cu, and a second high purity alloy with 4 Al and 1% Cu. The first type of alloy is used for government stores, since it has greater dimensional stability and greater retention of impact strength after aging than the second, even though it is not quite so strong nor as easily cast.

Impurities are closely controlled, and recently it has been specified that no lead or tin shall be used in the same building as that in which zinc alloy die castings are made. These die castings have given excellent service, even at temperatures as low as –68 C, for various types of fuses, mortar bomb tails, tank periscopes, Bofors gun foresights, anti-tank rifle grenades, tank carburetors, and shell nose caps.

Secondary zinc alloy contains a variable amount of copper, due to the brass inserts in the melting stock. The copper causes a greater variability in properties, so secondary alloy is used only for lower grade work.

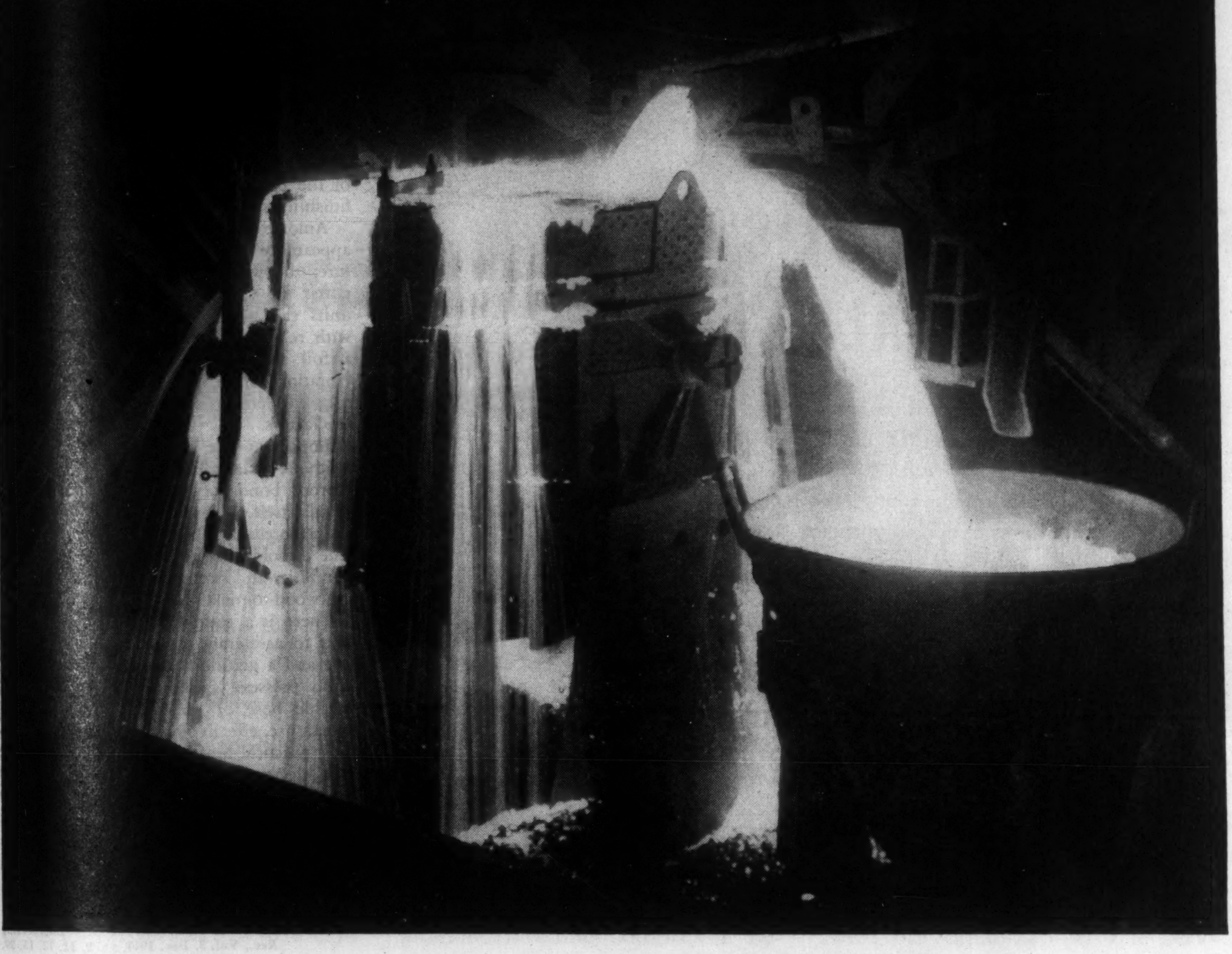
The other spectacular development has been the use of zinc alloy dies for forming and blanking of sheet metal for aircraft. A high copper alloy KM (similar to Kirksite) is used both in the cast and in the rolled condition. Although originally an antimonial lead punch was used with the zinc die, now both punch and die are generally zinc alloy.

These dies and punches have high compressive properties, good self-lubricating properties, and can be easily redressed or repaired with molten metal or remelted and recast. They are used with all types of drop hammers, Cecostamps, hydraulic presses and stretching presses. For forming, they are satisfactory up to 3/16-in. thick light alloy sheet, and for stainless sheet as used in aircraft engine exhaust systems. For blanking, they are used mainly on aluminum and its alloys.

Zinc alloy is being used to cast molds for plastic molding. Even deep cavities can be hobbed in cast zinc alloy blanks if the latter are heated to 175 C. Also, a new zinc alloy (type not given) is being used in the U.S.A. for die casting tire mold segments for rubber tire molding.

—B. D. Darrah. *Metallurgia*, Vol. 31, Dec. 1944, pp. 87-91.

SULPHITE-TREATED STEEL
Is Steel That's Had a "Bath"



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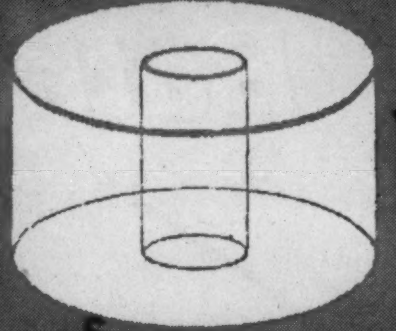

NONMETALLIC MATERIALS

Design-uses of plastics, plywood, fibre, glass, rubber, ceramics, etc. as engineering materials. Composite metal-nonmetal combinations. New types and forms of nonmetallic materials.

Use of Wood in Aircraft

Condensed from "Aeronautical Engineering Review"

The eminently successful fighter bomber of the British, the Mosquito, is the present standard for optimum wood aircraft construction. Other countries generally use more wood parts in their metal aircraft than in the United States.

Among the plywood parts that have been successfully used on metal aircraft are trim tabs, ailerons, wing tips and flaps. In more common usage are doors, flooring, cargo ramps, fairings, cable guards, and bomb bay doors. Troop benches and pilot seats are used to some extent. Wood and compreg wood propellers are used extensively by the British and Germans.

Around 1925 wood in airplanes receded and aluminum ascended, but in 1940 plywood began to make a strong return as a competing material. During this lapse, the art of construction of wood airplanes was largely lost, with artisans turning to other pursuits. Most engineers have had little or no training in its use, an unfortunate handicap. The fundamental cause of aircraft design troubles in wood lies with the extreme shortage of data on strength and elastic properties of wood.

Effect of stress concentrations has been extremely troublesome in wood structural design, particularly at bearing points for bolts, at cutouts in a composite structure, in certain types of panel loadings, and where heavy solid members are joined to thin plywood panels. The relationship of specific gravity to the strength properties of wood is now generally recognized.

Hygroscopicity of wood causes troubles, appearing as wrinkling of large, thin, unsupported panels, weight increase due to excessive moisture absorption, or loosening of metal fittings on heavy solid members because of shrinkage caused by excessive moisture loss. Close attention to balance of veneer thicknesses would eliminate much of the panel distortion. As yet, no perfect finishing material is available for wood.

Among the advantages of wood is the appearance of the molded plywood structure; the weight saving in lightly stressed parts; the savings in cost where plywood units can be fabricated in few parts and with relatively few internal members; rigid airfoil sections will be an advantage; the vibration dampening properties will be useful; excellent soundproofing and insulation are factors.

Important has been the development of synthetic resin adhesives that permit weatherproof bonds of wood stronger than the wood itself. Newly developed phenolics and resorcinol adhesives threaten to supersede the older ureas because of their greater durability and strength. Most promising are the wood-to-metal bonding materials.

There is a continuing increase in use of heat to accelerate the setting of the adhesive and a getting away from "C" clamps. Fluid pressure application in the form of flexible hose or diaphragms are in widespread use, effective on curved surfaces. The most practical heater has been the resistance-type electrical heater, with radio-frequency the most dramatic.

When resin-impregnated wood is compressed a densified material, "compreg," is produced, used for propellers, bearing plates for bolts, bearing pads and high strength inserts or small parts.

—Robert W. Hess. *Aeronautical Engineering Rev.*, Vol. 3, Dec. 1944, pp. 9, 11, 13, 15, 29.

New Glass Resists Hydrofluoric Acid

Condensed from "Glass Industry"

A new glass has been developed by American Optical Co., Southbridge, Mass., that is highly resistant to attack by hydrofluoric acid. Of the type known as phosphate glasses, the new material possesses other important properties that will make it a useful material of construction, especially in certain branches of the chemical field.

Although glass has become an important material of construction in the chemical industry, and the description "resistant to all acids except hydrofluoric acid" has become a standard phrase, it was the chemical field

LOOKING FOR A VERSATILE MATERIAL?

● The end bells illustrated above were manufactured by the Sampsel Time Control Company. Used as casings for covering the end connections of high speed electric machines, these small but vital items are no simple job to produce. The machine tolerances are quite close and the parts must have a high degree of stability. In fact the boring of a seat for a ball bearing is held to .0003″ tolerance while one shoulder diameter is turned to .0008″ tolerance.

As a result of an ingenious mold design, these end bells are molded in a single operation. Notice how the inserts are molded-in making for ease of assembly and fabrication.

The tremendous progress which America's custom molders have made during the past three years in developing new molding methods and processes is exemplified by the efficient production of just such items as these end bells.

The material selected for these end bells was a general-purpose Durez phenolic molding compound. Besides possessing excellent moldability, this Durez compound possesses such versatile properties as oil and grease resistance, dielectric strength, self-insulation, excellent wearability and heat resistance.

The unusual versatility of Durez phenolics has made their usage practically universal throughout industry. Add to this the quarter century's experience which Durez technicians have acquired through active participation in the successful development of many plastic products and you can readily appreciate the benefits of working with our organization. The services of the Durez staff are available at all times to you and your custom molder. Durez Plastics & Chemicals, Inc., 274 Walck Road, North Tonawanda, N. Y.

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TITAN BRASS PRESSURE DIE CASTINGS are helping build the huge aerial fleets that have made America's air supremacy a reality. A large portion of our production of Brass Pressure Die Castings are going into varied phases of aircraft manufacture, with the balance allocated to meet other requirements of our armed forces.

We have kept pace with the fast-moving developments and improvements that have outlined the future of American aviation. Peace will find Titan Brass Pressure Die Castings readily adaptable to meet the needs of new and improved products. They will help meet post-victory competition on every count of quality, production, engineering and cost.

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particularly that asked for the new glass.

Leaders in fluorine chemistry recognized the importance of being able to see what was going on in reaction vessels, and fluorine catalysts have become increasingly important in many processes. Aviation gasoline and synthetic rubber required fluorine compounds, while metallic fluorides have found new and expanding uses. The new glass stays transparent even if attacked.

The new phosphate glass developed by Dr. Alexis G. Pincus can be melted at about 2500 F., is easily blown or drawn from about 2000 F., and anneals at about 1100 F. Quality and color are good. Thermal expansion coefficient, about 5x10-6, is rather high, but the glass is tough and resists considerable thermal shock.

The material can be blown, drawn, cast, ground, and polished without any drastic modification of present processes.

—Glass Ind., Vol. 25, Dec. 1944, pp. 548-549.

Heat Stabilized Compressed Wood

Condensed from "Mechanical Engineering"

Solid, flat sawed non-resinous wood or veneer spread with glue assembled either in parallel laminated or cross bonded form can be compressed to a high specific gravity product that does not tend to spring back under moisture absorbing conditions if it is pressed so as to cause some flow of the lignin. This product is staypak.

Moisture contents over 15% should be avoided, and veneer with 6 to 10% moisture is preferable. A stabilizing temperature of 330 to 345 F. is best for large panels of birch and maple staypak. Deleterious moisture loss from the end grain of veneer during pressing is most effectively avoided by pressing cold before heating.

A pressure of 1400 p.s.i. seems adequate for yellow birch, 1600 p.s.i. for sugar maple, while 2000 p.s.i. is greater than necessary for yellow poplar and may cause spreading of the panels and reduced shear strength at right angles to the direction of compression. If the pressure is too low, the product is far less dimensionally stable and strong.

It is recommended that the product always be compressed to a specific gravity of at least 1.30. It should be cooled under full pressure to a temperature somewhat below the boiling point of water. There must be some side restraint to prevent spreading. The time of pressing will vary with the stabilizing temperature, moisture content, and thickness. The thickness of the veneer has a negligible effect upon the properties, therefore 1/8 in. thick veneer is preferred, due to the saving in handling costs and glue.

Staypak can be successfully made from solid wood. There is no injury to preformed synthetic resin glue lines under the conditions required for making staypak, but casein glue is unsatisfactory unless the glue is set at the time of stabilizing. Staypak can be made of a variety of woods, but difficulty is encountered in stabilizing Douglas fir and ponderosa pine. If shear in the plane of the plies is important, staypak should be made of maple or birch.

Water Best Plasticizer

Attempts to plasticize the lignin at the

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Lumarith is an old name in the cosmetics industry. Recently these versatile materials have served as alternates for war-scarce metals in many new applications. These newer roles are increasing as packaging stylists develop designs that take full advantage of Lumarith's unique characteristics of extreme lightness, superb color range, transparency and easy moldability.

The Lumarith molded container carries "lightly" in the handbag. Its chipproof surface actually improves with handling. The jade-like "feel" is inviting in all seasons.

Lumarith plastics are adaptable to high-speed, multiple-cavity injection molding. Molded surfaces require very little finishing and polishing. Intricate designs, raised or impressed lettering and close fitting threads are readily molded. The toughness of Lumarith provides strength without bulk and makes thin cross sections practical. You are invited to consult the technical staff of the pioneer plastics producers for specific information relating to your manufacturing problems. Celanese Plastics Corporation, a *division of Celanese Corporation of America*, 180 Madison Avenue, New York 16, N.Y.

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SIMPLIFY
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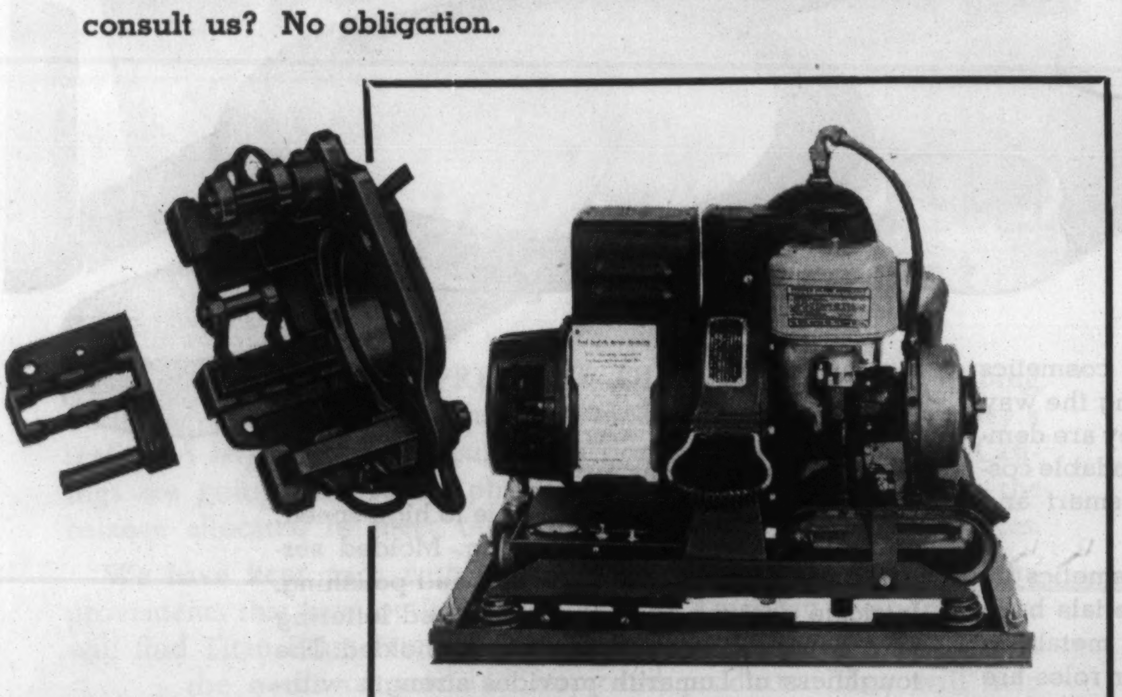
By die-casting brush holders and rings HOMELITE Corporation was able to junk a complicated rivet-and-weld assembly of twelve parts for a stronger, more dependable one of only two parts, in their well-known HOMELITE Portable Generators used in Army Liberators, Flying Forts and other planes.

In addition, by die-casting carburetor cover and fittings more time and money were saved.

Moreover, it was found that the tolerances in every case were close enough to make unnecessary any machining.

Think what this means! With limited available manpower HOMELITE was able actually to turn out a better product faster and at lower cost.

This is no unique experience. Again and again, in all manner of industries, ADVANCE castings have made other forms of fabrication obsolete overnight. You, too, perhaps? Why not consult us? No obligation.



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ENGINEERS, DESIGNERS AND MANUFACTURERS OF DIE-CASTINGS OF "QUALITY WITH ECONOMY"
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time of pressing further by using yellow poplar pre-treated with 10% urea, hexamethylene tetramine, formaldehyde, pyridine, glycerine and a diacetone alcohol solution of lignin showed that the use of plasticizers other than water is not practical.

Staypak weathers on the surface like normal wood. It can be glued to itself or to normal wood with various hot and cold-setting urea and phenolic glues.

Staypak has advantages over densified wood (normal untreated wood compressed without flow of the lignin) and over compreg (resin treated compressed wood stabilized in the compressed form by the resin). Densified wood tends to lose its compression under conditions which cause swelling. Staypak will swell considerably but will return to its original thickness, while it is possible to make compreg with negligible springback.

The tensile strength, bending strength, modulus of rupture and modulus of elasticity in bending are significantly higher for staypak than for compreg of the same specific gravity, while compreg has slightly higher compressive strength.

The chief advantage of staypak is the Izod impact strength, which is generally twice that of compreg. Moreover, staypak can be glued more readily than compreg. Staypak has little if any resistance to termites, and is considerably inferior to compreg.

Staypak should have many uses. Propeller blanks of staypak are being tested. Due to its greater swelling, it is not as good as compreg for water-lubricated bearings and other underwater uses, but it should be more suitable for spars, various fittings, tool handles, mallet heads, pulleys, silent gears and various tooling jigs and dies.

—R. M. Seborg, M. A. Millett & A. J. Stamm. *Mech. Engineering*, Vol. 67, Jan. 1945, pp. 25-31.

Plastic Bearings

Condensed from "The Engineers' Digest"

Plastic bearings, although generally satisfactory, occasionally fail due to lack of uniformity of the plastic materials used. Swelling of the material is another variable factor that influences results as well as the structure and nature of the bearing surfaces that affects lubrication.

Comparative tests of plastic bearings made of various materials have been made with an apparatus developed by the Technical College of Dresden to test bearings up to 60.25 mm. diam. and 40 mm. width. The bearings were tested under static loading conditions. A standard oil (BC 8) and two types of synthetic oils (S4 and S2) were used to gain information on the influence of lubrication.

The tests showed that performance varies for the same type of resin with different filler materials and to a lesser extent with the type of lubricant. Therefore, not any type of filler can be used with a certain type of resin. It was also proved that the bearing properties are independent of hardness and that the resin content is of little importance. Of the special type of plastics, fillers of jute fibres did not show up well.

In order to eliminate the effect of swell-

PLASTICS in the Industrial field

OTHER TYPICAL PLICATIONS

AMINATED

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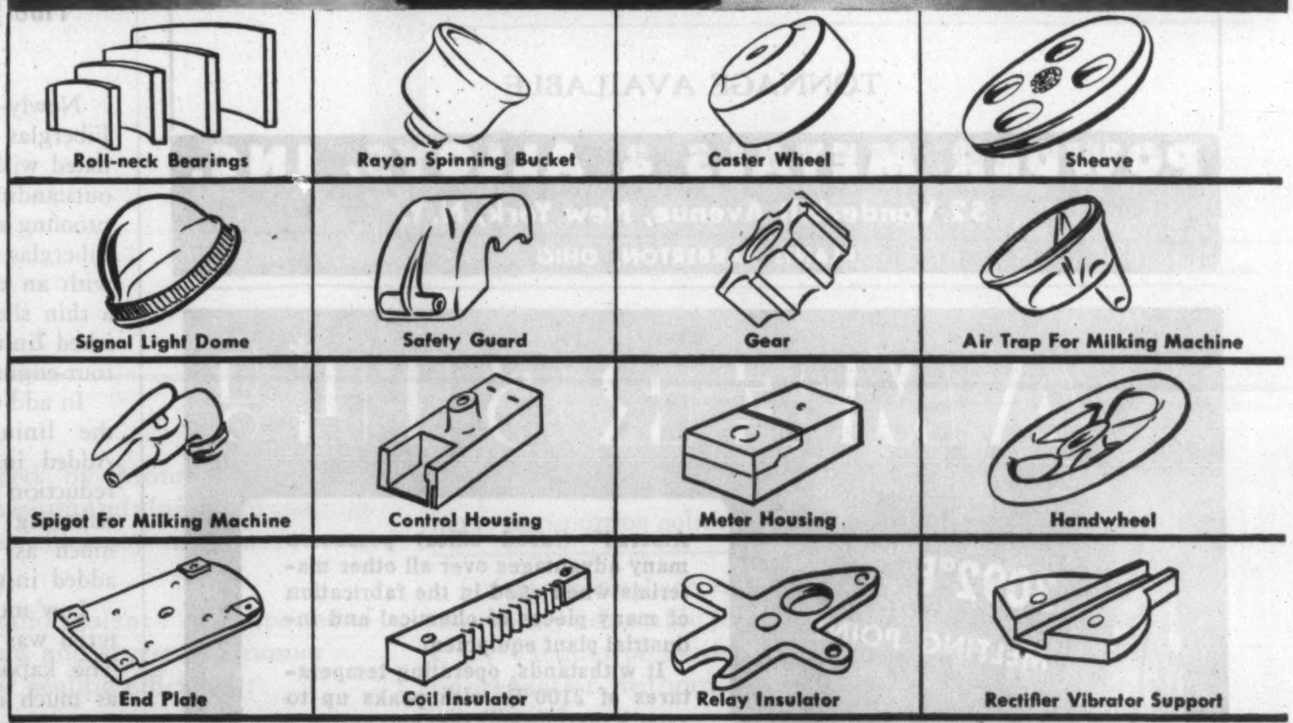
GEARS OF LAMINATED TEXTOLITE


Roll-neck Bearings
Rayon Spinning Bucket
Caster Wheel
Sheave
Signal Light Dome
Safety Guard
Gear
Air Trap For Milking Machine
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Meter Housing
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To reach a sound conclusion to your problem in plastics consult the skilled technicians—engineers and designers—of the General Electric Company. For advice on the successful application of plastics materials using all available processes of manufacture, write Section H-28, General Electric Company, One Plastics Avenue, Pittsfield, Mass., or call the General Electric Plastics Divisions' office nearest you.

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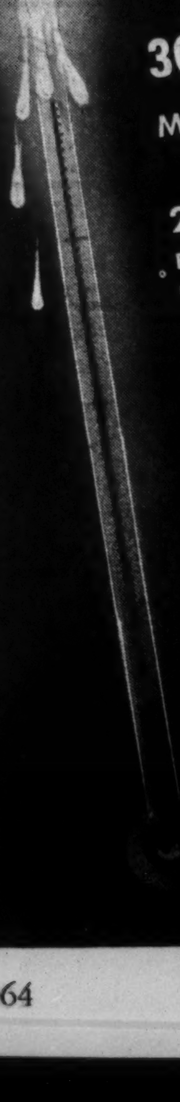

3092°F
MELTING POINT

2700°F
FOR SHORT
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COEFFICIENT OF
EXPANSION IS
0.000000054
PER DEGREE
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ing, which varies for the different types of material, all bushes were designed with a clearance of 0.25 mm. on 60-mm. diam. Clearance for clearance plastic bearings, probably due to their surface effect, which results in an orientation of the oil molecules, permit a larger quantity of oil flow than metallic bearings.

As they soften at relatively low temperatures, thermoplastic materials were not expected to be of much use for bearing applications. However, Mipolam showed good results, proving there is a useful field for thermoplastic bearings operated at high speed and comparatively low loads.

Experiments with water cooling showed that stable conditions are reached only at relatively high speed and that until then the danger of seizure is prevalent. However, owing to the lower viscosity of water as compared with oil, the rate of flow of water is much greater and combined with its high specific heat, the temperature conditions are very satisfactory.

—E. Heiderbroek & H. Zickel. *Kunststoffe*, Vol. 33, Oct. 1943, pp. 243-249; as abstracted in *Engineers' Digest* (British), Vol. 5, Dec. 1944, pp. 366-369.

Fiberglas-Resin Aircraft Linings

Condensed from "Plastics"

Newly-developed laminates composed of Fiberglas bonded with cloth and impregnated with thermosetting resins are making outstanding progress in low-weight soundproofing and protection of aircraft interiors. Fiberglas batts ½-in. thick are combined with an extremely light interior cloth and a thin sheet of cellophane to form the finished lining. Weight savings of 200 lb. per four-engined bomber have been reported.

In addition to soundproofing the interior, the lining provides thermal insulation. Added insulating qualities have permitted reduction of size of heating and heat-distributing equipment to the extent of as much as 70 lb. in return for 30 lb. of added insulation.

Low moisture absorption by the new material was found to be an added advantage. The kapok blanket formerly used gained as much as 40% in weight under service conditions due to moisture pickup. It weighs 0.331 p.s.i. in the 1-in. thickness. The new insulation, weighing one-fourth as much, picks up no moisture when subjected to 125 F. and 90% relative humidity.

The Fiberglas-resin material is also fireproof, and because of chemical inertness, causes no corrosion of the metals with which it comes in contact.

Under test conditions simulating tropical atmosphere, absorption of moisture at 125 F. and 90% relative humidity for 50 hr. showed the following percentage increases in moisture content: Fiberglas XAA-PF, 1%; rock wool, 1%; paper-base insulation, 47.5%; kapok, 190%.

The Fiberglas lining is also produced in a different form, as hard sheets $^{1}/_{16}$-in. thick, installed in cargo planes to prevent damage to the fuselage skin when loading or unloading the planes. The material has high impact strength, light weight, ability to withstand severe vibration, and dimensional stability over a range of temperatures and humidity changes.

—*Plastics*, Vol. 2, Feb. 1945, p. 66.

get Thalid Casting Sealant and you get these 5 advantages:

1. **High Sealing Efficiency**

2. **Clean Surfaces**

3. **Resistance to Gasoline and Other Solvents**

4. **Easy Handling in Plant or Foundry**

5. **Stability Under Operating Conditions**

Thanks to Thalid, developed by Monsanto's Plastic Research Laboratories, magnesium and aluminum castings now can be sealed with an efficiency and ease never before possible.

Here are the reasons a Thalid sealant . . . compounded of a thermo-setting base resin and styrene monomer . . . is able to offer such superior sealing efficiency:

. . . **low viscosity,** to insure thorough penetration of finest pores (2.8 centipoises for magnesium sealant formulation).

. . . **no solvents** to form vapor or air voids.

. . . **rapid polymerization** at low temperatures.

. . . **positive adhesion** to metal, with formation of rubbery, non-porous solids in pores.

Other practical advantages: (1) Thalid casting sealants are readily adaptable to standard impregnation methods, i. e., vacuum-pressure impregnation, positive pressure impregnation, without changes in equipment or methods, (2) Thalid casting sealant is supplied either pre-mixed for uniform results and simplicity in handling or as a base resin to be mixed with styrene monomer.

If your present casting sealant is not giving you these advantages, write, wire or phone for complete information on Thalid casting sealants and how you can adapt them in your operations. MONSANTO CHEMICAL COMPANY, Plastics Division, Springfield 2, Massachusetts.

The large and versatile family of Monsanto Plastics includes: Lustron polystyrenes • Cerex heat resistant thermoplastics • Vinyl acetals • Nitron cellulose nitrates • Fibestos cellulose acetates • Thalid for impression molding Resinox phenolics • Resimene melamines • Forms in which they are supplied include: Sheets • Rods • Tubes • Molding Compounds • Industrial Resins Coating Compounds • Vuepak rigid transparent packaging materials.

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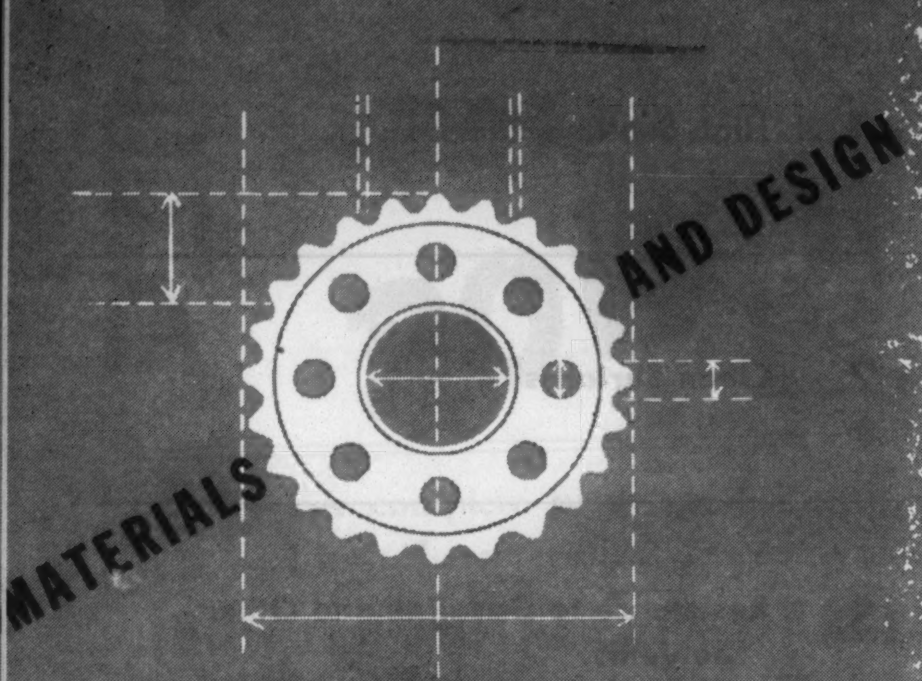


GENERAL PRODUCT DESIGN

Selection, applications and design of parts made by various fabricating methods or made of special materials. Properties and uses of finishes and coatings. Design and materials for specific products or fields. General engineering design trends or principles.

Improvements in Ferrous Castings

Condensed from "S.A.E. Journal"

Developments and improvements relative to static ferrous castings made in recent years are at least partly the result of wartime necessities, requiring the adoption of castings for highly stressed parts. The greatest change has taken place in steel foundries.

There is greater utilization of duplex and triplex systems incorporating the Bessemer converter. Greater care in proper refining of the molten metal through proper control of the boil, recarburization, deoxidation, and slag has greatly improved the quality of the steel.

A few years ago the practice of complete boil and recarburization was considered unorthodox for acid furnaces. New types of hardeners and deoxidizers that aid in control of hardenability, grain size, and inclusions also help to make better castings.

Studies of internal stresses, mass effects, and other factors have resulted in a better understanding of designed factors and many improvements in methods of gating and risering. These, new mold materials, and improved methods of sand control have improved the soundness of castings.

Substitution of castings for many forgings and fabricated assemblies has led to the adoption of many of the forging steels by foundries. Copper-bearing and high-carbon steels, which had few applications as wrought steels, are rapidly becoming important cast-steels. The general tendency appears to be toward standardization of cast-steels along the lines of NE steels, and it is probable that within a year or so standard NE compositions for cast-steels will be in use.

Increased use of liquid quenching has made possible the wider application of castings for highly stressed parts, and has brought about a better realization of the importance of the hardenability factor as an indicator of how the material will respond to heat treatment. Many foundries are using hardenability tests as part of their routine testing. Use of flame, induction, and other selective or differential hardening methods has made it possible to adopt castings for many parts formerly made by other methods.

The inadequacy of the conventional test-bar for testing and inspection has led to wider application of actual load tests. These consist of loading the castings to a predetermined limit in a manner that will produce stresses similar to service conditions and may consist of impact, static, or dynamic loading.

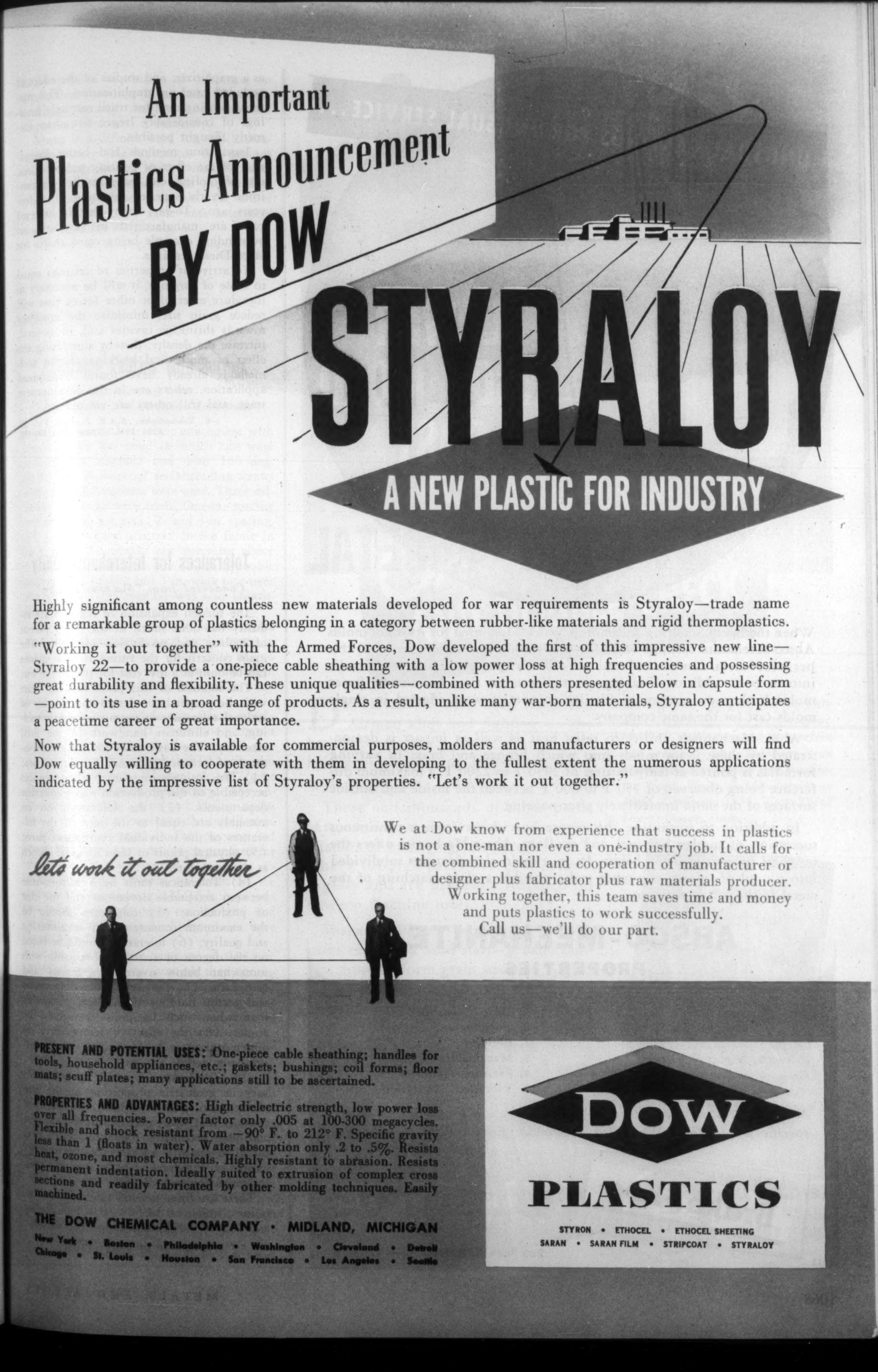
"Fiber Test" Adopted

The Army Ordnance Department has lately adopted a "fiber test" for certain steel castings. This requires that a sample, consisting of a test lug either attached to the casting or cast as a separate coupon and representing the average thickness of the casting, be fractured after having received the same heat treatment as the casting. The fracture must have a fibrous character and be free from any crystalline appearance to be acceptable.

X-ray inspection has become standard for determination of soundness, and today about 50% of American steel foundries use it to control their product. Magnetic methods also are finding wider application in inspection.

The ideal design of a casting is one where all members of the part increase progressively in thickness to one central location, where a riser or feeder can be placed that will supply the metal required to offset shrinkage. As this is not always possible, it is frequently advantageous to cast the part in sections that later can be joined together.

Recent developments in the malleable-iron industry have been directed towards improvements in metallurgical control; effects of various additions, particularly boron



An Important

Plastics Announcement

BY DOW

STYRALOY

A NEW PLASTIC FOR INDUSTRY

Highly significant among countless new materials developed for war requirements is Styraloy—trade name for a remarkable group of plastics belonging in a category between rubber-like materials and rigid thermoplastics. "Working it out together" with the Armed Forces, Dow developed the first of this impressive new line—Styraloy 22—to provide a one-piece cable sheathing with a low power loss at high frequencies and possessing great durability and flexibility. These unique qualities—combined with others presented below in capsule form—point to its use in a broad range of products. As a result, unlike many war-born materials, Styraloy anticipates a peacetime career of great importance.

Now that Styraloy is available for commercial purposes, molders and manufacturers or designers will find Dow equally willing to cooperate with them in developing to the fullest extent the numerous applications indicated by the impressive list of Styraloy's properties. "Let's work it out together."

let's work it out together

We at Dow know from experience that success in plastics is not a one-man nor even a one-industry job. It calls for the combined skill and cooperation of manufacturer or designer plus fabricator plus raw materials producer. Working together, this team saves time and money and puts plastics to work successfully. Call us—we'll do our part.

PRESENT AND POTENTIAL USES: One-piece cable sheathing; handles for tools, household appliances, etc.; gaskets; bushings; coil forms; floor mats; scuff plates; many applications still to be ascertained.

PROPERTIES AND ADVANTAGES: High dielectric strength, low power loss over all frequencies. Power factor only .005 at 100-300 megacycles. Flexible and shock resistant from −90° F. to 212° F. Specific gravity less than 1 (floats in water). Water absorption only .2 to .5%. Resists heat, ozone, and most chemicals. Highly resistant to abrasion. Resists permanent indentation. Ideally suited to extrusion of complex cross sections and readily fabricated by other molding techniques. Easily machined.

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LOWER INGOT MOLD COST PER TON OF METAL

When the Barth Smelting & Refining Works, Inc. used for its ingot molds Absco-Meehanite castings of a Heat-Resisting classification, its mold cost per ton of metal cast was reduced more than 39 percent. This does not take into account additional savings in replacement time because of fewer molds broken on conveyors. Similar economies were effected in single molds cast for the same company.

Absco-Meehanite's ability to resist heat as well as impact is demonstrated by these ingot molds into which bronze and brass in varying formulas is poured at temperatures of 2050°F to 2200°F, a maximum difference being observed of 750°F to 800°F between the inside and outside surfaces of the mold immediately after pouring.

In addition to sustaining this severe heat shock from a continuous succession of sudden heatings and coolings, Absco-Meehanite offers the range of properties listed below. Its four main classifications subdivided into a total of twenty-one types make possible a close matching of the metal to the job it must do.

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PROPERTIES

1. Strength (Shear, Compressive, Tensile and Transverse)
2. ✓ Impact Resistance
3. Corrosion Resistance
4. Wear Resistance
5. ✓ Heat Resistance
6. Toughness
7. Rigidity
8. Machinability
9. Pressure Tightness
10. Vibration Absorption

Meehanite castings permit close control of physical properties for your specific application. Write for Meehanite Engineering Handbook.

AMERICAN Brake Shoe COMPANY

BRAKE SHOE AND CASTINGS DIVISION

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as a graphitizer; and studies of the effect of occluded gases on graphitization. This material is being used for truck rear-axle housings of considerably larger size than formerly thought possible.

Inoculation methods and better knowledge of the effect of pouring temperatures, rate of cooling, etc., have resulted in cast-irons greatly superior to those of a few years ago. To-day, many highly stressed parts are manufactured in cast-iron, an outstanding example being crank-shafts for large Diesel engines.

To arrive at properties of castings equal to those of forgings, it will be necessary to introduce external or other forces that will reduce grain size, minimize the tendency towards shrinkage cavities and, in general, increase the density, thereby simulating the effect of mechanical working. Some such methods already have found widespread application, others are in the development stage, and still others are yet unborn.

—G. Vennerholm. *S.A.E. Journal,* Vol. 53, Feb. 1945. Trans. pp. 103-109.

Tolerances for Interchangeability

Condensed from "Machine Design"

The sudden expansion of the aircraft industry has done much in the development of tooling and production methods. The main concern for the future is how planes can be built at a low cost for peacetime use. The solution of this problem must start with the proper basic design and the use of rational tolerances to permit economic tooling, and eliminate handwork in the final assembly. The basic rules for the establishment of practical rational tolerances are: (1) The designer must establish tolerances acceptable to the production and inspection departments; (2) the tolerances on an assembly are equal to the sum of the tolerances of the individual component parts; (3) physical points or faces must be chosen as datum points.

(4) Tolerances must be a compromise between acceptable deviations and the cost of production; (5) tolerances should be the maximum consistent with engineering and quality; (6) tolerances should be based on the degree of accuracy obtainable with somewhat below average personnel and equipment; (7) the use of offset dimensions will permit holding much closer tolerances than when such locations are given by angles; (8) the effect of temperature on dimensions must be recognized where dissimilar materials are used.

(9) Tolerances in many cases should vary in geometric proportion to the size of the parts; (10) the tool designer must consider tool wear, part and unit distortion and other production tolerances; (11) it is useful to retain a tolerance reserve not indicated on the drawing to be available only for inspection and salvage.

There are three general tolerance classifications: unilateral (1.500+0.015–0), bilateral (1.500±.015) and range (75 to 80).

(Continued on page 1071)

More detailed expression of tolerances on production drawings is needed. Closer cooperation among design, production and inspection personnel is necessary.

There is a definite need for standardization of acceptable tolerances for castings and forgings among aircraft manufacturers working in cooperation with the vendors who produce these materials. It further is believed that the same base tolerances can be used for all metals.

—F. A. Wedberg. *Machine Design*, Vol. 17, Jan. 1945, pp. 117-122.

Attaching Fabrics With Screws

Condensed from "Automotive and Aviation Industries"

A new method of fabric attachment with metal screws was tried in which ribs were individually dimpled and 4-48 100 deg. flush head Shakeproof self-threading screws with dimpled washers were used. Three different spacings were tried. One-in. spacing test averaged 8.8 p.s.i., 2- and 3-in. spacing, 5.1 p.s.i. Failure occurred in the fabric in each case. To obtain test pressures above 5.5 p.s.i., it was necessary to use a double thickness of fabrics and 3-in.-wide tape over the screws. This method was also unsatisfactory.

A separate test was made to determine corrosion characteristics of steel screws in aluminum alloy sheet. After 980 hr. no sign of corrosion was found, although 24STAL sheet was pitted at points away from the screws.

To establish a satisfactory fabric attachment method, it was determined that a standard rib form should be used and that 4 p.s.i. in an 0.20 gage 24STAL rib also would be necessary. Washers of 0.032 gage 24STAL were found satisfactory. The addition of Gimble paint and Phillip recess head to the screw improved the installation.

Ribs were formed in the conventional way, then holes were drilled or punched for the screw. Spacing ranged 1 to 3 in., according to load. Fabric was fitted in the same way as for lacing, a 7/16-in. tape was located in a depression on the rib, and washers were installed. Screw holes were located with an awl.

Tests showed that washers of 0.032-in. material gave greater strength than continuous strip 0.020 in. thick, and were easier to fabricate and install. With 2 in. spacing of screws, the screw attachment weighed 9% more than the lacing attachment.

These screw attachments showed strength equal to the bursting strength of the fabric, with ribs of 0.020 gage and over, and screw spacing of 1.5 in. Rib spacings affect fabric strength greatly. Strength of attachment can be increased by reducing screw spacing, but strength of the fabric limits strength of the covering as a whole.

Tests conducted to determine the proper type of washer to use showed that Shakeproof SP 1351-4-4 washer assemblies and SP 1228-4-4 screws with AN 960-A6 washer achieved the desired results.

—Milton A. Miner. *Automotive & Aviation Inds.*, Vol. 92, Jan. 1, 1945, pp. 32, 34, 36, 38, 40, 88.

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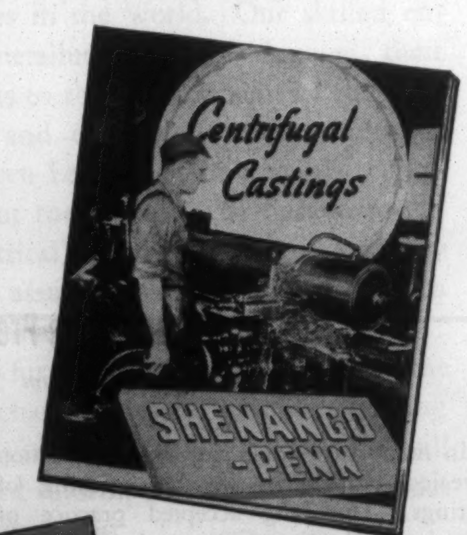
AND DOUBLE CHECK

DESTINED to help keep American Airmen aloft and fighting. . . the bronze parts you see above must pass the height of painstaking inspection. They must be precise . . . flawless . . . strong!

These and thousands of other parts, large and small, are proving the wisdom of specifying "Shenango-Penn", where tubular parts are cast centrifugally and are precisely finished on modern machine tools.

Shenango-Penn's centrifugal process gives castings a head start—greater density, more uniform grain structure, higher tensile strength, less porosity, no blowholes. No wonder they pass inspection with a very minimum of rejection and are better able to cope with shock, stress, wear and every kind of punishment.

Bulletin 143 will give you complete data including alloy specifications, physical and chemical properties, and reasons why Shenango-Penn castings conserve metal and machining time. Write to Shenango-Penn Mold Company, 1555 West Third Street, Dover, Ohio.



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ARMY E NAVY

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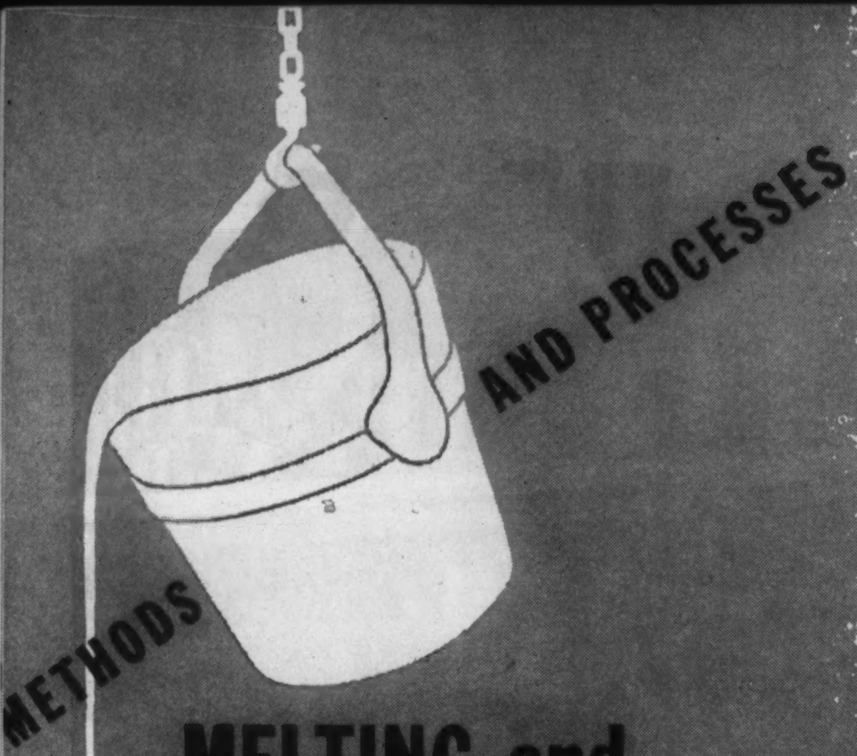


MELTING and CASTING

Melting, alloying, refining and casting methods, furnaces and machines. Iron and steel making, nonferrous metal production, foundry practice and equipment. Die casting, permanent mold casting, precision casting, etc. Refractories, control equipment and accessories for melting furnaces.

Oxyacetylene Processes in the Foundry

Condensed from "The Welding Journal"

In many steel foundries, war production revealed bottlenecks in the finishing of castings. The long accepted practice of chipping and grinding were slow, and appreciable speedups seemed impossible.

Some foundrymen have solved this problem by using oxyacetylene processes—machine cutting of risers, flame gouging, scarfing and descaling. In addition to eliminating the bottleneck, a far greater production per man-hour was realized, and the finishing cost per casting was reduced. Even small concerns found that the oxyacetylene equipment quickly paid for itself in decreased costs of production.

The machine flame-cutting of risers makes possible a cut that is smoother, straighter and closer to the surface of the casting than is possible with a manually operated torch; thus, the amount of grinding is reduced. Women can handle the equipment as easily as men.

Riser cutting by machine falls into two general classifications, straight-line and circular. In the former, the machine travels along a straight track cutting a riser adjacent to the track. In circular cutting, the machine either travels in a circle around the casting or the casting moves on a turntable around a fixed torch.

A more extensive application of the principles of flame-cutting is that of profile cutting. In this process, sections of castings may be removed by the use of a pantographic device in which a tracer on one part of the machine follows a template and translates every change in contour to the movement of the torch which is cutting the casting.

Scarfing is another oxyacetylene process that has recently been adopted by progressive steel foundrymen. Scarfing is a variation of flame cutting in which only the surface metal is removed. The best application of scarfing is in the removal of riser pads and riser stubs.

Another type of oxyacetylene process applicable to the foundry is the gouging process. Like scarfing, gouging consists of the removal of excess surface metal. In contrast to scarfing, no special torch is necessary, only a standard torch fitted with a gouging tip. This process was designed for the removal of fins and webs from casting, and for gouging defects such as cracks from localized areas. The use of flame-gouging effects savings in time and manpower because one flame-gouger can do the work of as many as ten chippers.

Flame descaling is still another oxyacetylene process that is applicable to foundry operations. By using a flame descaling torch, heat treating scale is flaked off castings by passing the high temperature flame over the surface of the casting. The scale spalls off the casting due to the differential expansion of the scale and the steel when heated locally. The process has definite limitation. Sand intermingled with the scale causes a stronger bond between the steel and the scale so that no spalling results.

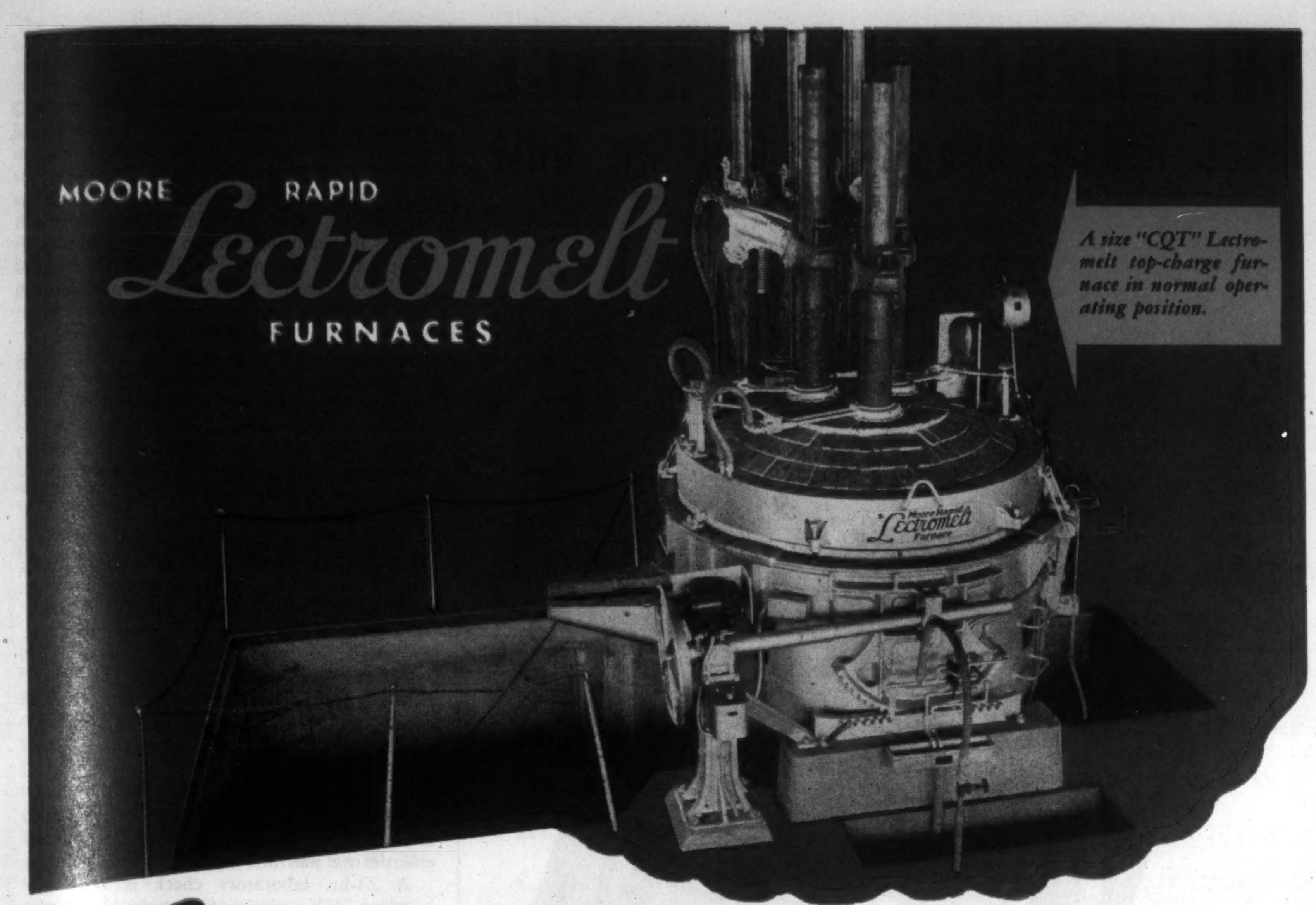
Flame heating is still another oxyacetylene process that can increase efficiency in the production of castings. Local heating for a peening operation is an application. One foundry reports elimination of trouble in peening a 5-in. diam., 20-in. length connecting pin in place by flame heating the ends rather than furnace heat the whole pin.

—G. E. Bellew. *Welding J.*, Vol. 24, Jan. 1945, pp. 25-35.

Ford's Tri-Alloy Bearing

Condensed from "Automotive and Aviation Industries"

The principal advantage of "tri-alloy," developed by Ford Motor Co., is its ability to stand up in bearings under heavy load at high speed operations. In road tests,



A size "CQT" Lectromelt top-charge furnace in normal operating position.

Outstanding IN FOUNDRY MELTING

Lectromelts have been prominent in foundry operations for more than twenty-five years. Today, there are more Lectromelt furnaces engaged in the melting of quality steels and irons than any other type of electric furnace.

The same size Lectromelt furnace with the roof swung aside, being charged by a drop bottom bucket. Due to the rapid charge, less time is lost between heats.

We are the largest exclusive manufacturer of electric furnaces in the world. Our skilled engineers and metallurgists have devoted their time and efforts to the development of the simplified design and exclusive operating features which have given Lectromelt an enviable reputation throughout the world. The best in mechanical and electrical design have been successfully coordinated to assure dependable operation with a minimum of maintenance.

Lectromelt furnaces are available in both the door and top-charge types in capacities ranging from 100 tons down to 25 pounds. We will forward detailed information on request without obligation on your part.

ARMY E NAVY

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THE CRUCIBLE FURNACE
Most Widely Adaptable Melting Unit

Navy ingenuity sets up crucible furnace in the field Used for salvaging brass and copper. Official U. S. Navy photographs

IN every Non-Ferrous foundry, large or small, whether equipped with the most modern furnaces or a "Jury Rig" outfit (see illustration) Crucible melting pays best.

It pays best in low investment required, in low melting loss, in saving in capital required, in low stand-by charges, in adaptability to many usual and unusual installations, and in flexibility to meet your coming varying tonnage requirements.

Year after year, your foundry will profit best when you standardize on Crucibles for all your non-ferrous melting. To see what others are doing with Crucible melting, write for the "Crucible Melters' Handbook." Sent on request.

CRUCIBLE MANUFACTURERS ASSOCIATION

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some bearings and crank-shaft journals showed no measurable wear at the end of 50,000 miles. In general, bearing wear factor is about the same for cadmium and tri-alloy bearings, with the crank-shaft journal showing a little more wear when the tri-alloy bearing is used.

Tri-alloy consists of 35 to 40 Pb, 4½ to 5% Ag, balance copper, with a trace of iron. It has been known that single-face copper-lead bearings were easy to make, but when coating both sides to make floating bearings, segregation of lead created weak points. This did not take place in tri-alloy.

The casting process, set up on a continuous basis, starts with a large coil of low carbon, open-hearth, hot rolled, pickled steel strip 2 in. wide and 0.075 in. thick. By means of knurled rolls the steel is pulled through a coating furnace. As the strip passes through the furnace, at 2100 F., it is preheated in the upper part of the furnace and immersed in a bath of molten copper-lead-silver. It then passes into a forming die, which allows just the desired amount of metal to leave the bath to conform to the desired form.

Graphite is used for the die. The lower half of the die extends below the bottom of the furnace and is encased in a water jacket, which causes the alloy to solidify and chill down to 200 F.

A shearing machine cuts the alloy into segments of about 11 in. long, enough for three bearings. Pieces are run through a chamfering machine to bevel edges.

A 24-hr. laboratory check is kept on bonding and analysis of the mix. Bonding is tested by hammering a strip double and inspecting for adhesion.

Percentage of scrap has been reduced to 5 to 7%. On a comparative cost basis, tri-alloy is more expensive than the cadmium type, but the company hopes to narrow the differential to a point where the differences in cost will not be prejudicial to their use in postwar automobiles.

—Leonard Westrate. *Automotive & Aviation Inds.*, Vol. 92, Jan. 15, 1945, pp. 20-21, 96.

Inoculated High-Duty Cast Iron

Condensed from "Foundry Trade Journal"

Ferrite, with silicon in solid solution, has a tensile strength of about 28 tons per sq. in. Pearlite, in its coarser formation, records about 40 tons per sq. in. Finely laminated, or sorbitic pearlite, such as it obtained by heat treatment, gives a tensile strength of around 80 tons per sq. in. It appears, therefore, that were it not for the strength-reducing effect of graphite, and other non-metallic constituents, cast iron could be produced approaching more nearly to the limit of 80 tons per sq. in.

Graphite has a specific gravity of 2.255, less than ⅓ that of cast iron, so that it occupies a volume in the structure at least three times as great as its weight. It is essential, where maximum strength is sought, to keep the total carbon to a minimum.

For cupola-melted irons, the minimum total carbon content that can be obtained

A FEW FACTS ABOUT CORHART PRODUCTS

Corhart Electrocast Refractories are high-duty products manufactured by melting selected and controlled refractory batches in electric furnaces, and casting the molten material into molds. After careful annealing, the finished shapes are ready for shipment. Dense, high-melting refractories, they are especially designed for resistance to corrosive action.

PRODUCTS

CORHART STANDARD ELECTROCAST is a high-aluminous refractory.

CORHART ZED ELECTROCAST is Zirconia-bearing.

CORHART ELECTROPLAST is a high-temperature plastic refractory made from Standard Electrocast which has been ground and crushed. Especially designed for ramming. Furnished dry.

CORHART MORTAR is a high-quality cement for laying up Electrocast, clay brick, or any aluminous refractory.

CHARACTERISTICS OF STANDARD ELECTROCAST

POROSITY: Less than 0.5%—therefore virtually no absorption.

FUSION POINT: Cone 38 without any appreciable softening below that point.

HARDNESS: 8, Mineralogist's scale.

SPECIFIC GRAVITY: Blocks weigh approximately 183 lbs. per cu. ft.

COEFFICIENT OF EXPANSION: 0.000006 between room temperature and 900° C.

SPECIFIC HEAT: 0.25 cal. per gm. per °C. at 980° C.

THERMAL CONDUCTIVITY: 25 BTU per sq. ft. per hour for gradient of 1°F. per inch.

COMPOSITION: Standard Electrocast is of an aluminous crystalline nature.

CORROSION: Because of low porosity and inherent chemical make-up, Corhart products are highly resistant to corrosive action.

APPLICATIONS

Most heat processes present spots where a better refractory material is needed in order to provide a balanced unit and reduce the expense of repeated repairs. It is for such places of severe service that we invite inquiries regarding Corhart Products as the fortifying agents to provide the refractory "balance" desired.

The following is a partial list of applications for which Corhart Products are suggested:

ELECTROLYTIC CELLS — for production of Magnesium and other light metals.

SILICATE OF SODA FURNACES — sidewalls, bottoms, and breastwalls.

HEARTHS AND SMELTERS — for non-ferrous metals.

ALKALI AND BORAX MELTING FURNACES — fast-eroding portions.

GLASS FURNACES — the entire installation of flux walls and bottoms, breastwalls, ports, tuckstones, forehearths, recuperators, etc.

RECUPERATORS—tile, headers, separators, etc.

ENAMEL FRIT FURNACES — flux walls and bottom.

BRASS FURNACES — metal contact lining.

ELECTRIC FURNACES — linings for rocking type, and rammed linings of Electroplast for this and other types.

BOILERS — clinker line.

STOCK SHAPES AND SPECIALS

Standard and Zed Electrocast are made in stock shapes and in many special shapes. The weight of individual pieces may run to 3500 pounds.

IF YOU NEED A BETTER REFRACTORY—

● Corhart Electrocast Refractories are high-duty products which have proved considerably more effective than conventional refractories in certain severe services. If your processes contain spots where a better refractory is needed to provide a balanced unit and to reduce frequent repairs, Corhart Electrocast Refractories may possibly be the answer. The brief outline at the left gives some of the basic facts about our products. Further information will be gladly sent you on request.

Corhart Refractories Company, *Incorporated,* Sixteenth and Lee Streets, Louisville 10, Kentucky.

"Corhart" is a trade-mark, registered U. S. Patent Office.

QUALITY ECONOMY ENDURANCE

CORHART ELECTROCAST REFRACTORIES

regularly is around 2.8 to 3.0%. Where steel scrap and pig-iron or cast iron are part of the charge, the latter should not be of high-phosphorus content, because of the large difference in melting points.

Braidwood reached the conclusion that the eutectic carbide breaks down after solidification to form iron and graphite. On the other hand, normal or random flake graphite is formed when irons solidify in the stable iron-graphite system, the graphite flakes in this case forming from liquid conditions directly from the graphite-austenite eutectic. The melt, therefore, should be treated in such a way that it is induced to freeze under the stable iron-graphite system, thereby obtaining normal graphitization.

For a long time it has been known that the addition of certain materials in crushed form to the molten iron will have the desired effect, and the technique has been termed "inoculation." It is known that the effect of inoculation is more pronounced in the lower carbon ranges. The majority of inoculation processes employ the silicon-bearing or softening type of inoculating medium. It is possible, however, to work in the reverse direction and to stiffen up a high-carbon equivalent material by means of a stabilizing or hardening inoculant.

Low-carbon irons are of hypo-eutectic composition. When an inoculant containing carbon-silicon or similar graphitizing agent is introduced into the melt, the liquid iron in its vicinity takes it into solution and becomes locally hyper-eutectic to such a degree that free carbon is immediately expelled from the solution in a very finely divided form. Then dispersing throughout the bulk of the liquid iron, it forms centers of crystallization and induces further deposition of graphite.

Graphitizing or softening inoculants contain silicon, calcium, and titanium, while the densifying inoculants of the carbide-stabilizing type include chromium and manganese. In the case of a heavy sectioned casting, even with a low-carbon equivalent iron, it might be necessary to use the stabilizing inoculant to ensure sufficient density and hardness.

Cast iron with high mechanical properties can be readily and consistently produced by the inoculation of low-carbon equivalent charges when molten in the ladle.

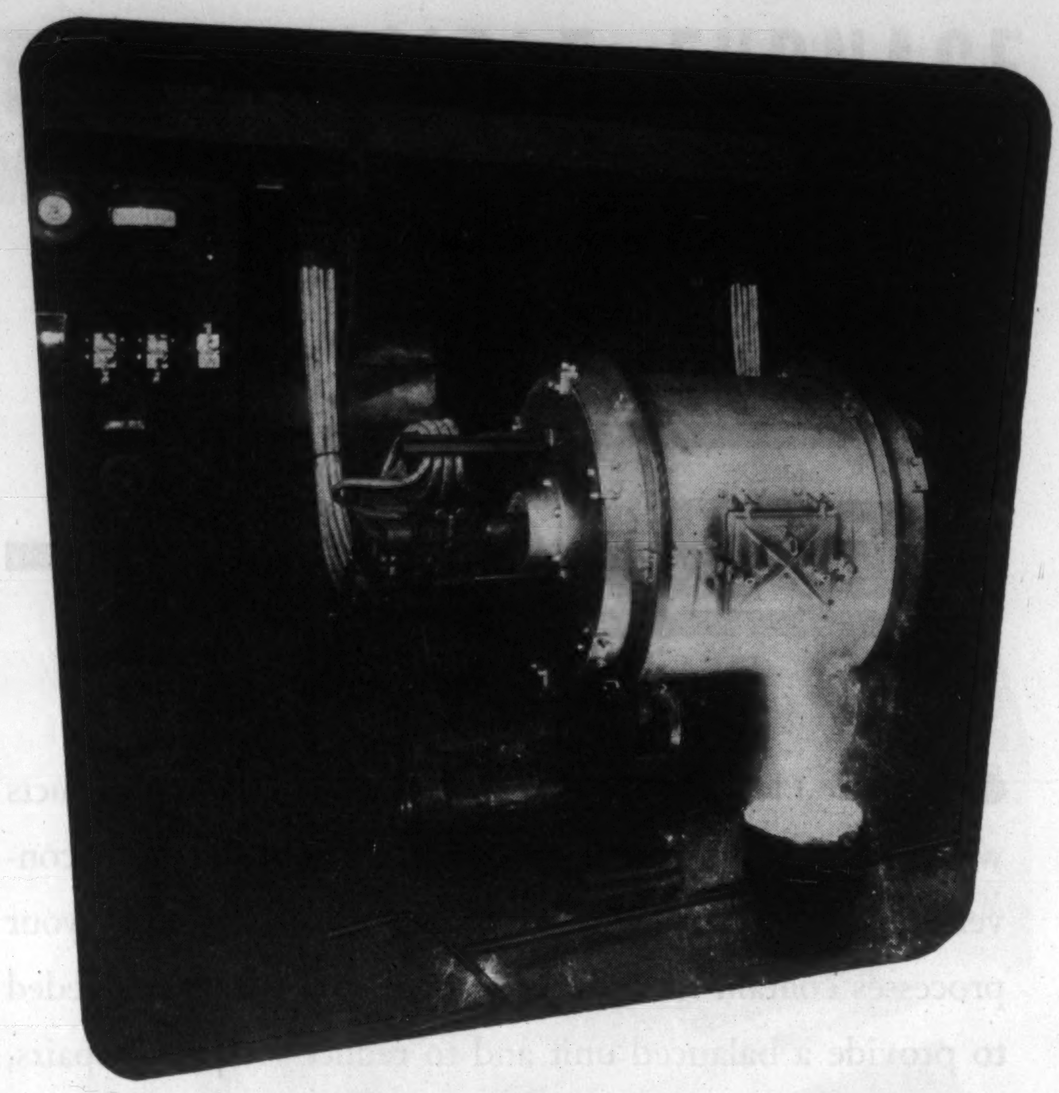
—J. L. Francis. *Foundry Trade J.*, Vol. 74, Dec. 28, 1944, pp. 335-341; Vol. 75, Jan. 4, 1945, pp. 7-10.

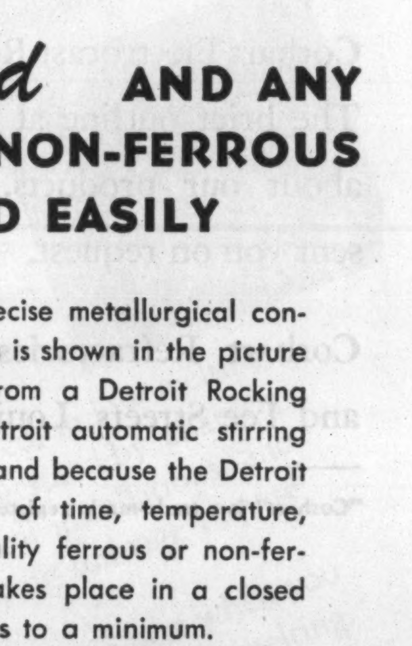
Porosity in Copper Alloy Castings

Condensed from "Canadian Metals and Metallurgical Industries"

Porosity in metals is generally caused by release, during cooling and solidification, of gases dissolved in the molten metal. Other causes may be molding sand with too high moisture content or damp crucibles or ladles.

For practical purposes, the following possibilities for producing porous castings must be considered: (a) Absorption of gases, such as oxygen, hydrogen, sulphur dioxide and carbon monoxide during melt-





Melts Ni-Hard **AND ANY OTHER FERROUS OR NON-FERROUS METALS QUICKLY AND EASILY**

Quickly heated to 2950° F. under precise metallurgical control, a quarter-ton of Ni-Hard cast iron is shown in the picture above being tapped into a ladle from a Detroit Rocking Electric Furnace. Because of the Detroit automatic stirring action under non-oxidizing conditions and because the Detroit Furnace design permits close control of time, temperature, and other melting factors, higher quality ferrous or non-ferrous castings are assured. Melting takes place in a closed chamber, thus reducing dirt and fumes to a minimum.

Versatile, flexible and fast, Detroit Rocking Electric Furnaces have proved their worth in scores of foundries. They insure faster melting—as many as eight ferrous or sixteen non-ferrous heats in one 8-hour day. And they assure more production per man hour with lower metal losses and less machine shop scrap. Detroit Rocking Electric Furnaces, available in sizes from 10 lbs. to 4 tons, are a sound investment in quality casting production in your foundry. Write for complete facts.

DETROIT ELECTRIC FURNACE DIVISION
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GUNMIX
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One of the newer products which has proved very successful for repair and maintenance of electric furnace sidewalls is Gunmix, applied to hot basic brick with the Gunmix air-gun.

ASK THE "BASIC" MAN YOUR $64 QUESTIONS

ALWAYS ready to help you, the Basic Sales Engineer who calls on you invites your questions. He may not know all the answers, but he is in position to help you find them . . . if it's a furnace refractory problem that's bothering you.

Basic Refractories' service is broadening steadily, the better to serve the steel and metal working industries. Nearly every steel producer knows and has used for years our standard refractories for basic open hearth and basic electric furnaces — hearth refractories for new construction, for major and emergency repairs, for heat-to-heat maintenance. More recently you have been acquainted with Basimix for forge and billet-heating furnaces and with Gunmix products for the maintenance of vertical side walls of electric and open hearth furnaces, soaking pits and other types of heating furnaces. Other products, too, and practical application methods are under way.

The Basic Sales Engineer's job is to help you use these products more effectively ...not only in the usual, long-established ways, but also to meet the more difficult, unusual situations. He has a wealth of knowledge and experience in refractories to place at your disposal, and even more important from your standpoint, perhaps, he is a practical steel man. He has spent years actually making steel.

So don't hesitate to take advantage of the "Basic" man's desire to help you in any way he can. Ask him your $64 questions.

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MAGNESIUM MELTING

FOR WAR AND PEACE HAUSFELD FURNACES SUPPLY THE DEMAND FOR BOTH LARGE AND SMALL UNITS FOR OIL AND GAS FUELS

ILLUSTRATION SHOWS 1700 LB. CAPACITY FOUR BURNER GAS FIRED MOTORIZED NOSE TILTING FURNACE

STATIONARY SIZES FROM 100 LBS. UP

FURNACES FOR BRASS • ALUMINUM AND ALL OTHER NON-FERROUS ALLOYS

The Campbell-Hausfeld Co.
200-220 MOORE ST. HARRISON, OHIO

ing and alloying; (b) formation of gases by interaction of non-metallic constituents or impurities, such as sulphur, arsenic and carbon with metallic oxides.

(c) Drawing air into the metal during pouring through the runner; (d) development and decomposition of steam by the hot metal in the mold; and (e) moisture content in ladles and crucibles insufficiently dried. Porosity caused by the last three possibilities can be avoided by observance of proper foundry controls.

The extent of porosity depends on the solubility of the gases in question, both in the liquid metal and in the solidifying metal and on the cooling rate of the alloy.

Sulphur is introduced into the metal through the fuel used for melting the metal. Strong deoxidizers will reduce sulphur dioxide present and produce cuprous sulphide, which is very undesirable. Therefore, sulphur either should be prevented from entering the metal or should be eliminated if present before casting.

Chemicals such as alkali or alkali earth carbonates react with sulphur, but it is easier to use protective fluxes which effectively prevent the take-up of sulphur by the metal. However, if sulphur has entered the metal, it should be removed by a combined treatment with a sulphur-removing slag and the addition of a metallic constituent which readily combines with the sulphur, such as magnesium, lithium, calcium, and others.

Besides the disadvantage of expense, the excess of metal remaining in the melts will often adversely affect the properties of the alloys. Bringing the sulphur down to 0.05% results in a sulphur content that is not objectionable for most purposes.

One of the main causes of porosity in copper alloy castings is hydrogen and water vapor. The introduction of hydrogen into the metal from reducing furnace gases will result in oxidation of the hydrogen during pouring. This produces water vapor, which is much less soluble than the hydrogen, and porosity will ensue.

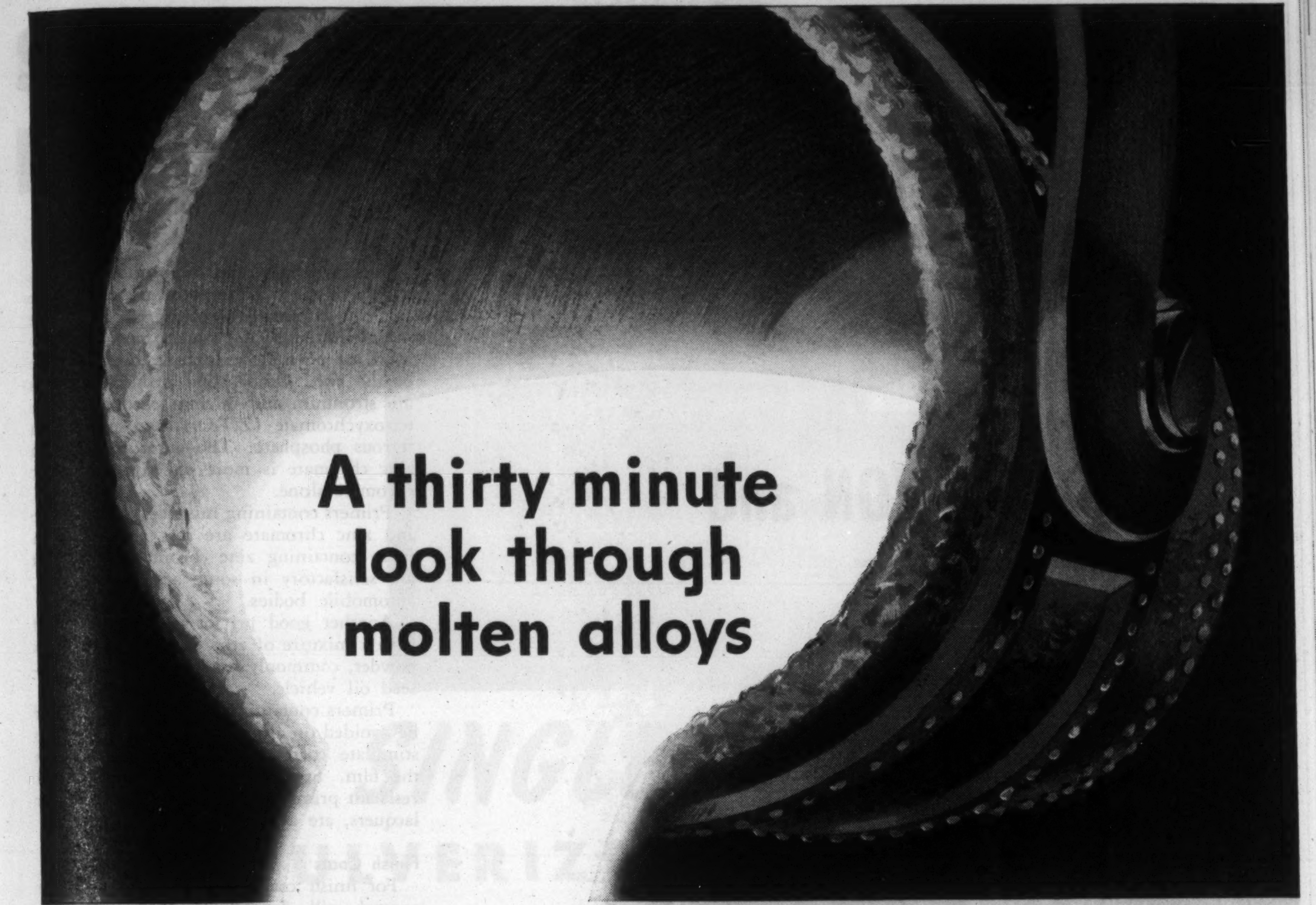
Recent research has shown that the addition of oxidizing fluxes will largely overcome hydrogen and water vapor porosity. Metal so treated should be strongly deoxidized with phosphor copper.

Carbon monoxide may enter the molten metal either from strongly reducing furnace gases, from graphite melting crucibles, or through carbonaceous materials in the molding sand. However, by applying a good covering flux and melting under slightly oxidizing conditions, the danger of porosity can be largely eliminated.

To reduce the danger of gas porosity in copper alloy castings, the following precautions should be taken: (1) Use clean material as far as possible; (2) if alloy is melted from virgin metal, deoxidize the copper with phosphor copper before adding the tin; (3) protect metal with an oxidizing flux during melting and heating.

(4) Runner should be kept full during pouring to prevent sucking of air into the stream of metal; (5) melting and pouring temperatures should be kept as low as possible to reduce the rate of gas absorption; (6) gates and risers must be of proper size and be placed in proper positions; and (7) the molding sand must not be too damp nor too high in clay content.

—K. Strauss. *Canadian Metals & Metallurgical Inds.*, Vol. 8, Jan. 1945, pp. 27-28.



A thirty minute look through molten alloys

Every foundryman knows that molten brass should be cast as soon as possible after it reaches the pouring temperature to assure good castings. The same is true of ingot.

But to give you ingot true to specification we must know accurately its composition while it is still in the furnace. This determination formerly took hours. Now it is done at Michigan Smelting & Refining in thirty minutes or less by using the Densitometer (shown below) in conjunction with the Spectrograph.

This rapid method of determining the presence of each element and in what quantity allows us immediately to do further refining to eliminate all injurious impurities and then make additions of alloying ingredients as required to bring the molten metal up to your specification.

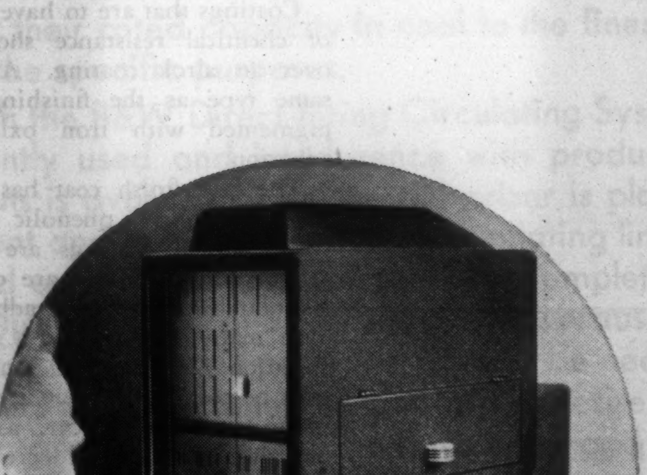
This is your assurance that you get exactly what you order when you do business with this organization.

MICHIGAN SMELTING & REFINING

Division of

BOHN ALUMINUM & BRASS CORPORATION • Detroit 26, Michigan

General Offices Lafayette Building



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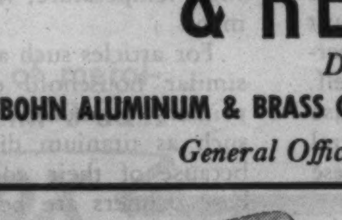
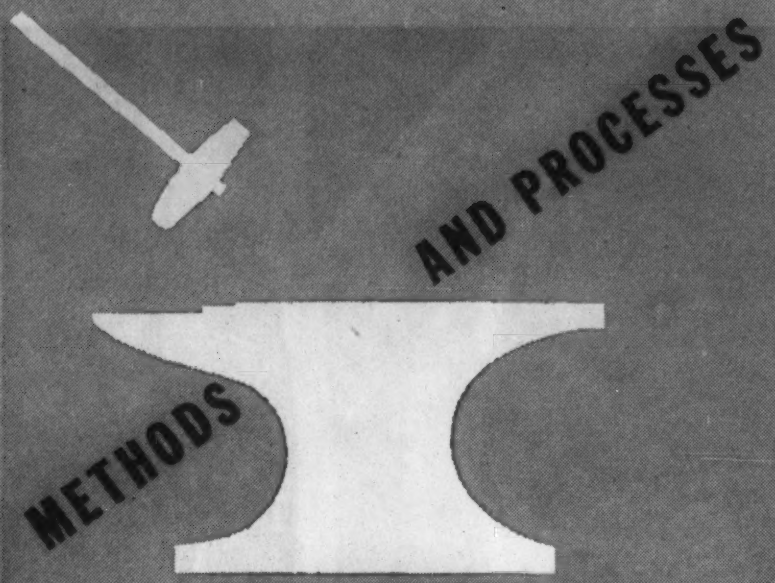
WAR
BONDS**



**NON-FERROUS
SCRAP METAL REFINERS
FOR OVER 50 YEARS**



FABRICATION and TREATMENT

Machining, forging, forming, heat treating and heating, welding and joining, cleaning and finishing of solid materials. Methods, equipment, auxiliaries and control instruments for processing metals and nonmetals and for product fabrication.

Painting Aluminum

Condensed from "Industrial Finishing"

Primers serve to bond the finish to the metal surface and, therefore, a primer must have good adhesion to the metal and permit good adhesion of the finish to itself. Under some conditions the primer must also have corrosion inhibiting properties. Several different primers for aluminum meet these requirements.

In addition, primers must sometimes be flexible, in order to permit forming operations on primed material. Vinylite-resin coatings, alkyd oil modified coatings, and phenolic-resin coatings, baked at a relatively high temperature, fulfill the latter requirement.

For articles such as refrigerator parts and similar household equipment, alkyd base primers pigmented with white pigments such as titanium dioxide are widely used because of their good adhesion. Phenolic base primers are better on such things as washing machine parts because of their imperviousness to moisture and better resistance to alkalis.

On surfaces that will be wet frequently or will be exposed to industrial fumes, a primer with corrosion inhibiting properties should be used. Zinc yellow, the trade name for zinc chromate pigment, is one of the most effective. The vehicle may be either alkyd or phenolic-resin base, or a mixture of the two. Other good primer pigments are strontium and calcium chromates, zinc tetroxychromate (Z.T.O.), and ammonium ferrous phosphate. The latter mixed with zinc chromate is more effective than zinc chromate alone.

Primers containing mixtures of iron oxide and zinc chromate are less effective than those containing zinc chromate alone, but are satisfactory in some applications, *e.g.*, automobile bodies.

Another good primer is one pigmented with a mixture of zinc dust and aluminum powder, commonly used with a treated linseed oil vehicle.

Primers containing lead pigments should be avoided on aluminum, as they appear to stimulate corrosion if moisture penetrates the film. Special black primers, chemical resistant primers, and primers for use under lacquers, are available.

Finish Coats

For finish coats, the choice of paint or enamel will depend on the service for which the article is intended. Urea-formaldehyde has good abrasion resistance but does not have good weather resistance. Aluminum paint has high resistance to moisture penetration. Alkyd-resin formulations are adaptable to roller application and withstand forming operations well, and are used on sheet to be formed into bottle caps, signs, etc.

Coatings that are to have a higher degree of chemical resistance should be applied over an alrok coating. A primer of the same type as the finishing coat is used, pigmented with iron oxide to improve adhesion.

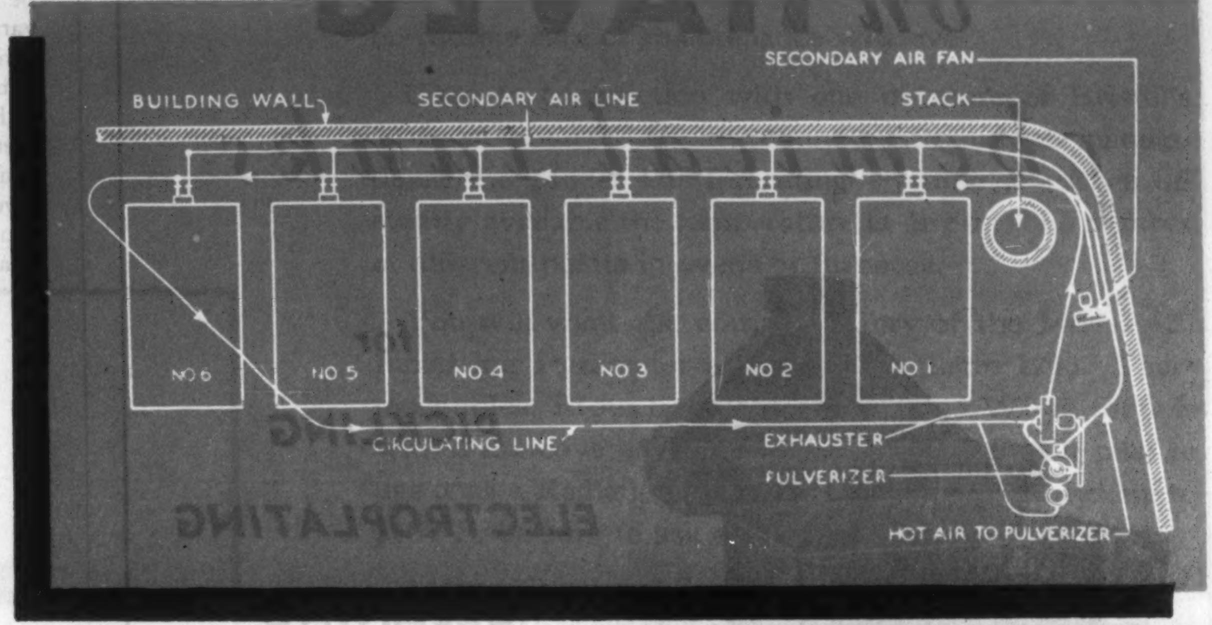
The best finish coat has been found to be heat-reactive phenolic resin coatings. Unpigmented coatings are best. Coatings of polyvinyl chloride are quite chemically resistant but have poor adhesion.

In many applications, *e.g.*, in the transportation industry, assembled structures must be painted. Frequently, joints between dissimilar metals occur, as between steel and aluminum. In order to prevent accelerated corrosion at such points, individual parts should be primed before assembly. Zinc chromate primers are recommended.

If corrosive environments are likely to be severe, *e.g.* involving salt water, a joint sealing compound should be applied in addition to the primer, in order to prevent access of moisture. Either a compound containing aluminum powder, filler, oils, and thinner, or a special Neoprene tape filler are suitable.

In refinishing assembled structures, a

SIX ANNEALING KILNS FIRED WITH PULVERIZED COAL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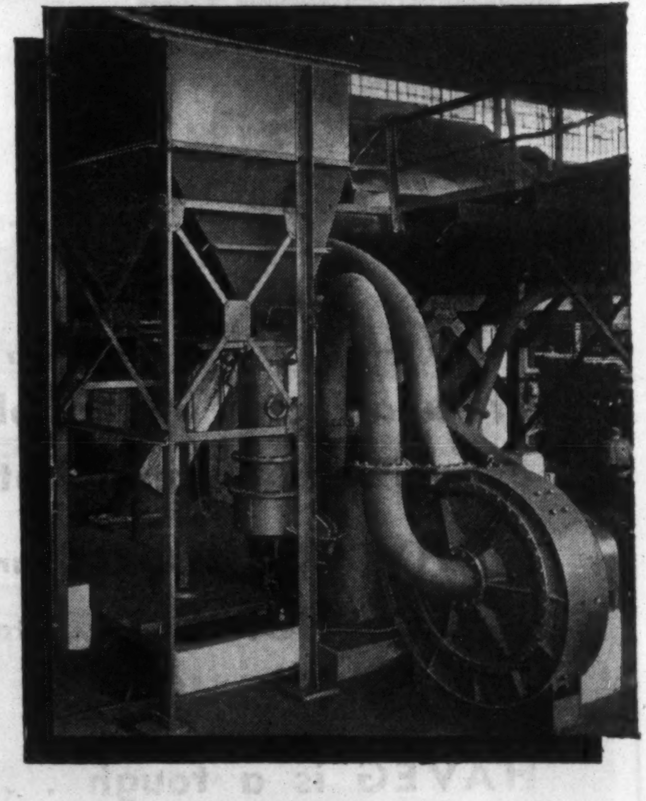

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For further details on pulverized-coal firing of metallurgical furnaces, write for a copy of B&W Bulletin 3-333.

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thorough cleaning by sand blasting or wire brushing is used, followed by an application of a 5% solution of potassium dichromate, which is allowed to dry, followed by zinc chromate primer, then by the required paint system.

In some applications it is desired to retain the natural bright finish of aluminum. For this purpose, various clear finishes may be used. Baked clear urea-formaldehyde varnish, or as a second choice a melamine resin coating are used where abrasion resistance is required.

For exposure to weather and sunlight, methacrylate or cellulose acetate-butyrate resins are good and will give protection for several years. Methacrylate lacquers will protect aluminum window frames from attack by alkaline mortar during erection.

—R. I. Wray. *Ind. Finishing,* Vol. 21, Jan. 1945, pp. 66, 69, 70, 72, 74, 76.

High Velocity Band Sawing

Condensed from "Mill and Factory"

The first practical band saw was introduced in 1846, but it received no special recognition until the early 1930's as a contour sawing machine. Contour sawing is still claimed as a most economical method by which to machine metals.

Experiments showed that a substantial increase in velocity resulted in increased cutting rates and improved finish. Need for additional chip clearance led to development of the free-cutting buttress type of saw, a unit free from vibration, capable of 10,000 f.p.m. Except for unique tooth design, it does not differ from the standard precision contour saw. Neither saw is ever resharpened. In the new type saw, elimination of deep-wedge-shaped gullets increases rigidity of tooth 100%, making for cool cutting and vibrationless qualities.

Increased band width means at least 50% more tensile strength, providing ample guiding width, with minimum stress concentration. The new coarse pitch saws will cut greater work heights, permit increased feeding pressure, precision contour sawing, straight accurate ripping along a dip fence, and square cuts with a cut-off bar. It does not lead, and expedites cutting of small radii.

The saws are available in four widths. The widest band should be used when possible, but the radius dimension governs the width to use. The machine is equipped with a 10-hp. variable speed drive, with range of 1500 to 10,000 f.p.m. Babbitt-lead, brass, silver and copper may be cut at 3000 to 4000 f.p.m. by using a band of 8 or 10 pitch.

The saw is good with standard contour machines, such as on SAE 1045 steel as thick as 8 in. and free machining steel up to 12 in. Likewise, it will cut gray cast iron and manganese bronze.

With a band covering about 2 miles per min. and 3500 diamond-tough teeth doing the "biting," friction cutting is now something to talk about. Skin or surface hardening of the finished cut is negligible. The saws reach peak efficiency after they have

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This instrument uses the millivoltmeter method of measuring thermocouple electromotive force in terms of temperature. An automatic cold-end compensator is built in, to make a single, rugged instrument requiring no routine care or maintenance whatever.

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Address The Bristol Company, 162 Bristol Road, Waterbury 91, Conn. (The Bristol Co. of Canada, Ltd., Toronto, Ontario. Bristol's Instrument Co., Ltd., London, N. W., 10, England.)

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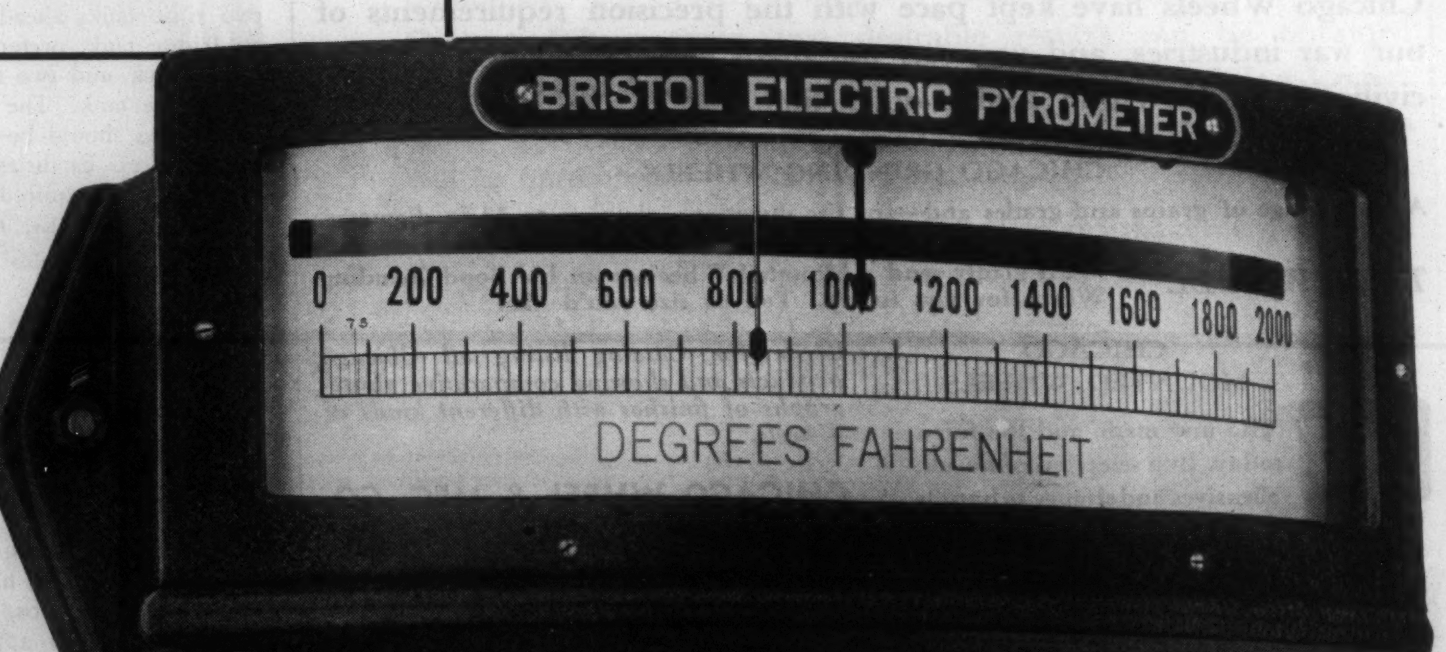

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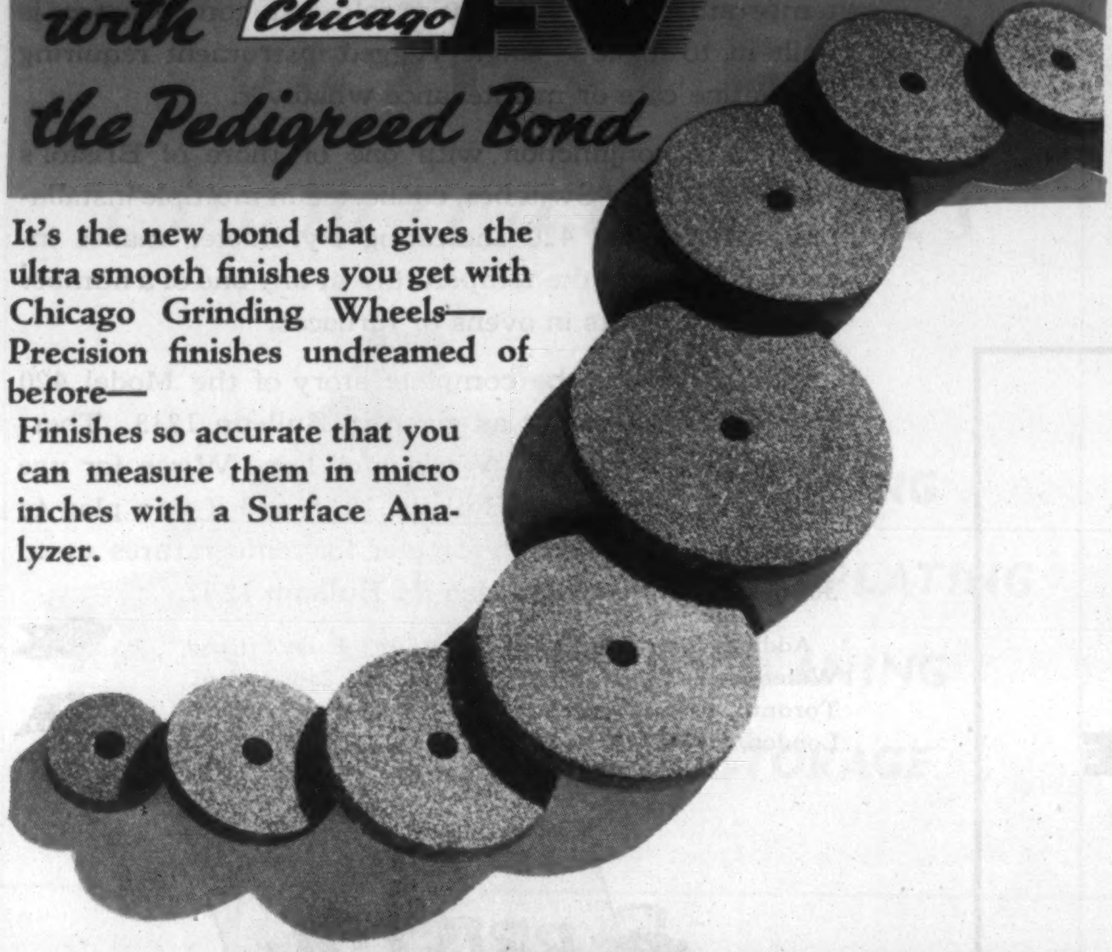

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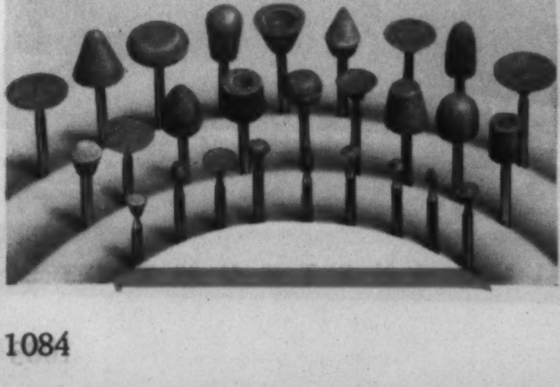

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been used for ½ hr., and saw life is long. Bands with teeth are most efficient since the softened chips are readily carried off from the kerf. The saw cuts satisfactorily until the teeth are almost gone.

Actual sawing and friction sawing differ insofar as velocity vs. thickness of cut is concerned. In actual sawing, one reduces the velocity as thickness increases; but with friction sawing, vice versa. With the buttress type saw, cutting rates of over 100 sq. in. per min. on aluminum and magnesium castings or solids are common.

—H. J. Chamberland. *Mill & Factory*, Vol. 36, Jan. 1945, pp. 124-125, 232, 236, 240.

Iridite Process

Condensed from "Proceedings" of the American Electroplaters' Society

The Iridite process is a proprietary process for coating zinc or cadmium with a chromate film, for the purpose of inhibiting the formation of white corrosion products. The Iriditing solution contains sodium dichromate and an unnamed acid.

It reacts with a zinc or cadmium surface to produce an olive drab film of hydrated chromic oxide gel. The thickness of the film is estimated to be between 0.00002 and 0.00004 in. It protects zinc from the formation of white corrosion products for about 200 hr. in the salt spray test.

The coating has an electrical resistance of 0.0016 ohms per sq. in. It is a good paint base. It has decorative value, and is well suited as a final nonreflective finish. Die castings and galvanized articles can be treated, but die-castings require a flash plate of zinc prior to treatment, or a pretreatment in hot caustic cyanide.

Operating procedures are simple, consisting merely of dip treatments. Equipment required consists of suitable cleaning tanks, two rinse tanks ahead of the Iridite tank, an Iridite tank, preferably lined with acid proof brick, and two rinse tanks following the Iridite tank. The second of the latter rinse tanks should be equipped with heating facilities. Facilities for drying the coatings are also required.

—A. G. Taylor. *Proc., Am. Electroplaters' Soc.*, June 1944, pp. 6-12.

Hand Honing Carbide Tools

Condensed from "Western Metals"

A slight chamfering of the cutting edge of a cemented tool by hand honing has been found, on many jobs, to increase the life of the tool. This applies mostly to the machining of steel. A carbide-tipped tool to be used for the machining of aluminum and most non-ferrous materials should not be honed.

Hand honing increases the life of the tool because scale and heavy chips are apt to make an extremely sharp cutting edge flake off. Honing also removes ragged portions of the edge sometimes present after sharpen-

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IT PAYS DIVIDENDS IN BETTER WORK AND GREATER PRODUCTION!
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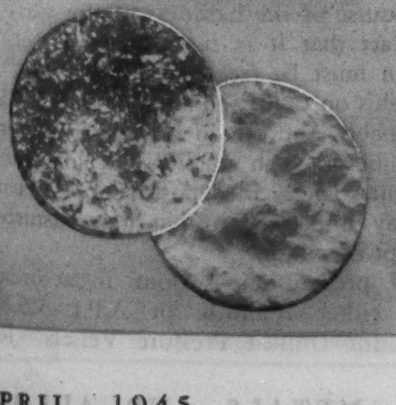

UNRETOUCHED PHOTO at left shows dirt left on filter paper before filtration of coolant. At right is shown what happened after the coolant was passed through a Briggs Coolant Filter. Notice the complete absence of dirt on the filter paper.

Briggs

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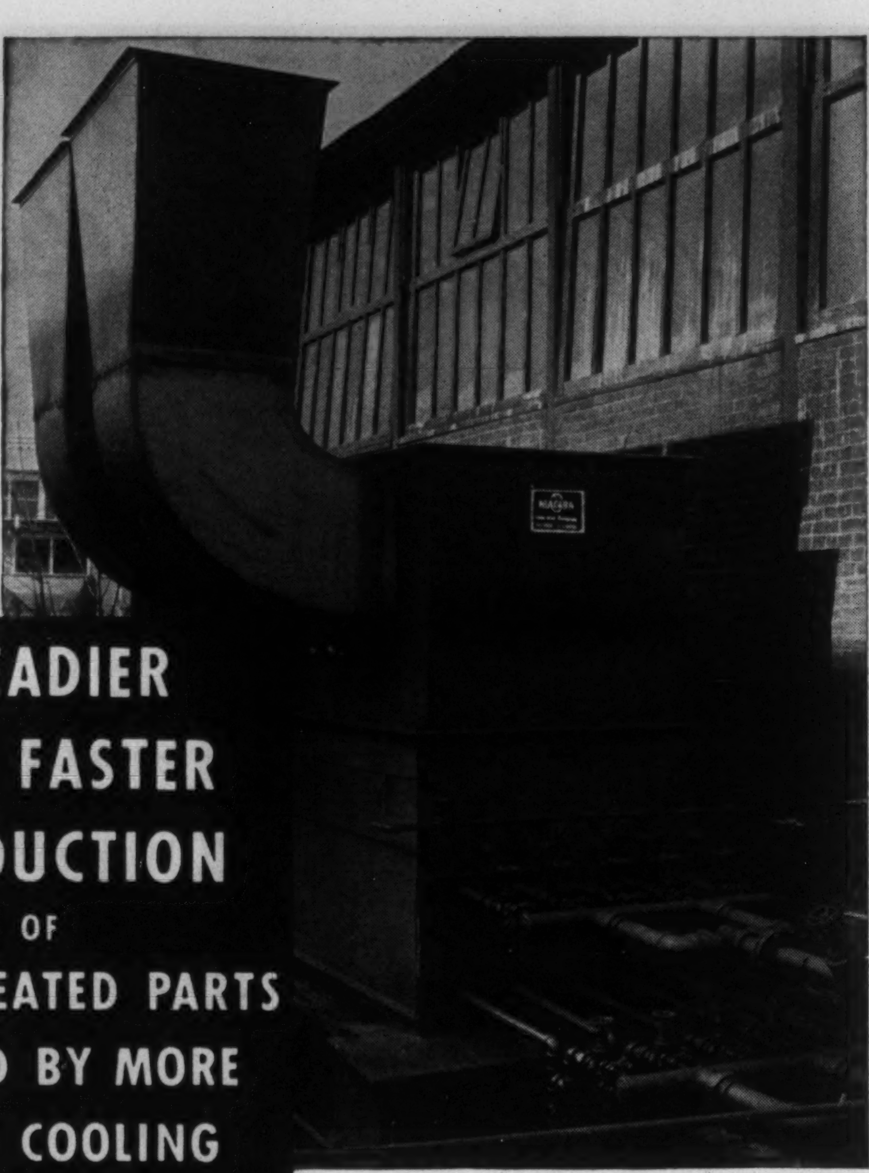
Consult the "Filter" section of your classified telephone directory to find the Briggs distributor in your locality or write manufacturer for complete information.



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OF
HEAT TREATED PARTS
GAINED BY MORE
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OF THE
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● In a certain plant, heat treating equipment planned to complete five units in a given time period was unable to produce better than three until the NIAGARA AERO HEAT EXCHANGER was installed to cool and control the quenching bath temperature.

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ing on an abrasive wheel. The amount of honing depends upon the job to be machined.

Tools used for making finish cuts should receive a very light honing. For heavy roughing or interrupted cuts, the flat, or chamfered surface left by the honing stone should be between 0.002 and 0.005 in. wide. For "light" cuts, too much honing will make the tool too dull to cut most effectively. Occasionally, for an exceptionally heavy cut, it is desirable to hone the edges of the chip breaker as well as the cutting edge of the tool.

When scaly stock is to be machined, or when interrupted cuts must be made, it is preferable to hone the part of the cutting edge that is outside the cut proper somewhat more than the part actually buried in the work. This prevents chips from the working part of the edge from breaking off the exposed part.

All honing should be done by an operator who is familiar with the particular machining operation on which the tool is to be used. Honing follows the finish grinding, and the stone should be of about 320 grit. A few seconds before the machining operation starts will pay big dividends, but it must be remembered that the honing must be done correctly.

—Fred W. Lucht. *Western Metals*, Vol. 2, Jan. 1945, pp. 56-57.

Welding Glass-Lined Vessels

Condensed from "Industry and Welding"

Glass-lined vessels and their accessories are at present used mostly in the chemical, food, pharmaceutical and dairy industries. In peace time, other large users are the brewing, distilling and cosmetic industries.

The glass lining provides a high degree of corrosion resistance, eliminates metallic contamination and simplifies the maintenance of cleanliness and sanitation. The steel structure provides sufficient strength for the vessel to withstand high working temperatures and pressures. High quality chemical glass is fused directly to the steel, and it is far more resistant than porcelain enamel.

Units for 311 lbs. per sq. in. internal pressure, having a capacity of 840 gal., have been built. The latest development is an autoclave for 1500 lb. per sq. in. internal pressure and 150 gal. capacity. At present, the largest one-piece, all-welded vessel that can be glass-lined is 12 ft. in diam. and 40 ft. long. This is a storage tank, not built for pressure. Longer tanks can be made in sections, but the diameter is limited to 12 ft.

Because of the hardness of the glass and the fact that it is fused to the steel, the design must be free of sharp corners, free of welds on radii, and sections must be kept reasonably uniform in thickness. The steel must be of high quality and low carbon content. The weld deposition must be free of any imperfection that may disturb or disrupt the glass.

All preparation is done in accordance with either A.S.M.E. or A.P.I.-A.S.M.E. Code for Unified Pressure Vessels. Joint

For Every Tough Metal Cleaning Job . . . The Right Magnus Cleaner

MAGNUSOL

An oil-soluble penetrating and dispersing agent, used in the Magnus Emulso-Dip and Emulso-Spray method for precleaning prior to electro or alkaline cleaning for electroplating; for cleaning after deep draws; after machining, cutting and grinding; after slushing oils; after buffing and polishing, etc., etc. Harmless to any metal. Gives a physically clean surface, ready for painting, lacquering or any finishing operation except plating or vitreous enamelling.

MAGNUS 94XX

An effective alkaline cleaner with super-wetting action. Used as a final cleaner after precleaning to get a chemically clean surface suitable for plating or vitreous enamelling. Exceptionally valuable in electrocleaning operations on steel. Also in extensive use on alkaline cleaning where no precleaning is required. 94XX has a unique brightening effect on steel surfaces on which it has been used. Works faster and rinses better, due to superior wetting properties.

MAGNUS 92SM

A special alkaline cleaner for soft metals such as brass, bronze, babbit and aluminum, designed to clean those metal parts and pieces after machining, cutting, grinding and similar operations which tend to spangle, tarnish, etch or discolor when cleaned in excessively alkaline solutions. 92SM is particularly valuable where pieces or assemblies have to be cleaned which contain more than one metal, such as units containing steel and babbit or steel and brass.

MAGNUS 755

A unique new emulsion-solvent type cleaner, originally designed to solve the difficult problem of removing burned in grease and hard carbon from airplane engines prior to reconditioning. Already in extensive use for cleaning railroad and stationary diesel engines and parts, aviation engines and parts and for gasoline engines and accessories, particularly carburetors, pumps and motor blocks. Harmless to all metals. Will apply to many tough metal cleaning problems.

MAGNUS ELECTREX LINE

A series of alkaline cleaners with superior wetting, penetrating and dispersing properties, designed primarily for use in electrocleaning operations. These cleaners are also used for any alkaline cleaning operation where a chemically clean surface is required. They are available in a range of compounds to cover every kind of metal, from steel, steel and brass combinations, die castings and aluminum and other soft metals. They rinse unusually fast and give much less trouble with drag over than ordinary cleaners.

MAGNUS HEAVY DUTY CLEANERS

A series of metal cleaners of higher alkalinity than those mentioned above for cleaning steel parts and pieces after drawing and stamping, salt bath annealing, slushing oils and oil quenching. These cleaners can also be used on magnesium alloys, but not on aluminum or other soft metals. Copper is only superficially tarnished by some compounds in the series, however.

Heavy Duty Cleaners can also be used to strip paint from parts and machines, prior to repainting.

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preparation depends on the type of welding to be done. Either oxyacetylene, metallic arc or automatic submerged melt welding is used.

The plates, sheets or heads to be joined are cut and trimmed either by machining or flame cutting. By machining most of the flat stock on a large planer, very close tolerances can be held. The heads are trimmed in a large boring mill converted for flame cutting. In order to keep the welds off the radii and prevent sharp corners, the openings are swaged into the heads.

In fabricating the vessels, the straight sided cylindrical portion is welded by either the manual arc or the automatic process, the latter usually only on units over 60 in. in diam. and 4 ft. long. Heads are completed as units within themselves before being welded to the ring. The nozzles require a combination of processes.

In general, smaller openings are gas welded on the inside and larger openings are arc-welded. The bottom head is welded first to the ring so as to be able to apply the automatic weld to both sides. The inside of the top head must be welded by manual arc, after which the outside is done by automatic welding.

Vessels to be jacketed must have the jacket sealer apron and bottom outlet diaphragm welded on and fittings must be welded to the outside of surfaces that will be covered with glass on the inside. The entire jacket cannot be applied before glass covering because uneven heating between the jacketed and unjacketed portion would produce too much warpage. After all welding except the jacket is completed, the vessel is normalized, sandblasted and inspected.

The glasses applied to the vessels are high grade boro-silicon glasses. They are fritted and then milled in ball mills with certain colloidal substances and water as a vehicle. The slip, resembling paint in appearance, is sprayed onto the surfaces to be lined and is dried by warm air. Firing is done in direct fired furnaces, either oil or gas.

Several coats, the number depending on the service for which the vessel is intended and the degree of perfection required, are added. After each coat the glass surface is inspected by a high voltage spark test.

—W. G. DeGray & G. L. Dawson, Jr. *Ind. & Welding*, Vol. 18, Jan. 1945, pp. 44-46, 52, 54, 56-60, 62, 63.

Rolling Alloy Steels

Condensed from "Iron and Steel Engineer"

Cogging practice for alloy steels at the Atlas Co. is determined by the grades rolled. After the ingot is worked to a billet suitable for the section required on a 22-in. mill, it is run down to the shear in the 26-in. mill line, the hot top is cut off and the billet transferred across to the 3-high 22-in. mill line. At the present time, a hot scarfing machine is being installed on the way to the shears before cutting off the hot top.

On all grades of high alloy steel, the ingot should be worked during the first

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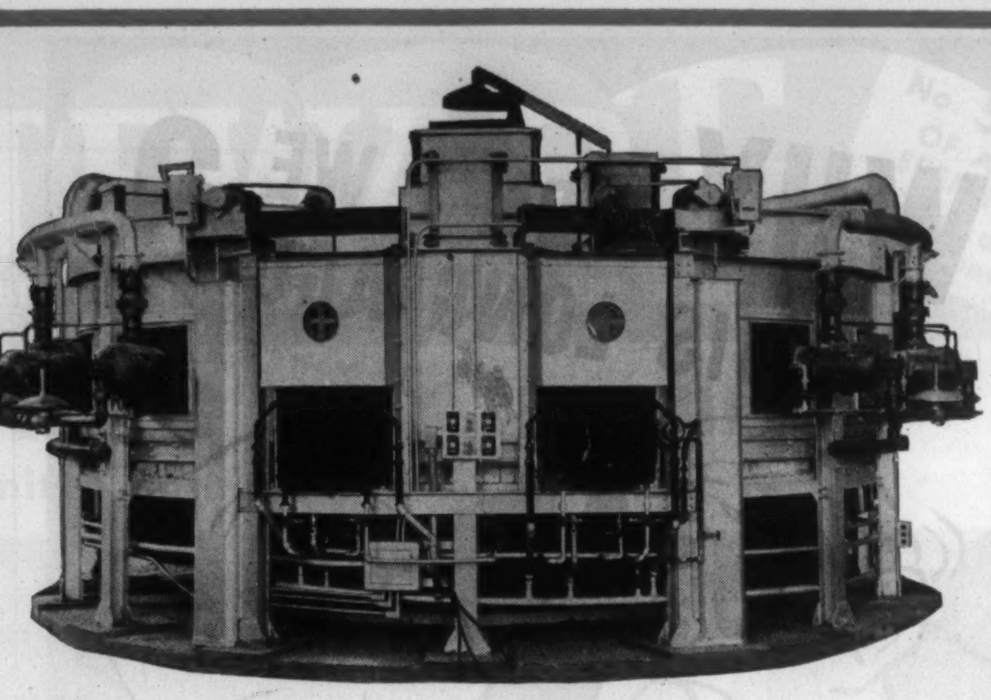
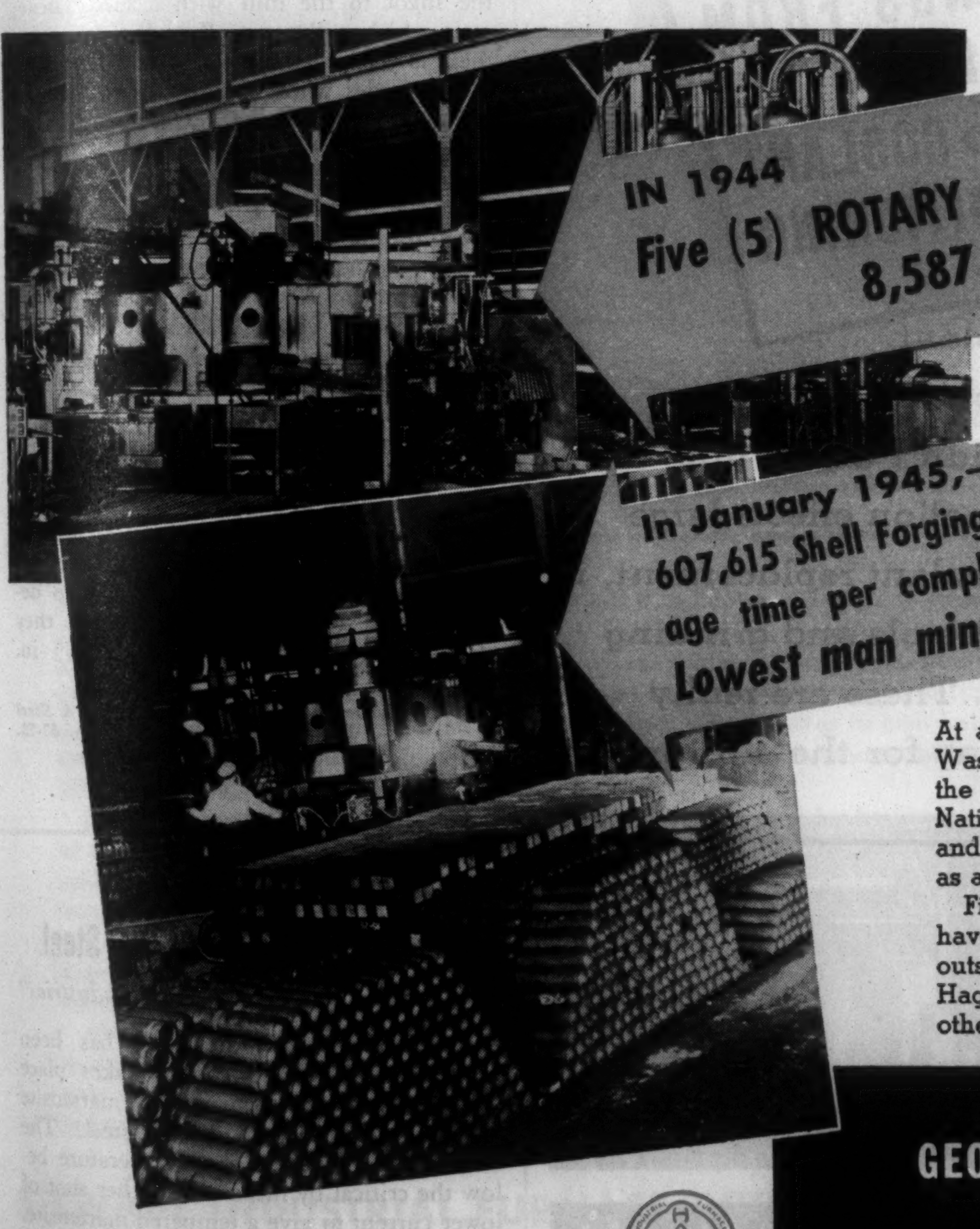
. . . used exclusively in W. P. B. MODEL SHELL PLANT



HAGAN *ROTARY HEARTH* FORGING FURNACES



IN 1944
Five (5) ROTARY FORGING FURNACES HEATED
8,587,605 Shell Forgings

In January 1945,—
607,615 Shell Forgings (105 mm. size) heated . . . average time per completed forging was 2.6 man minutes.
Lowest man minute labor cost in the industry

At a recent meeting of the War Production Board in Washington, D.C. the forging plant and equipment of the Ambridge plant of Spang-Chalfant, division of The National Supply Company—was chosen as the *best* and *most successful* in the country and is to be used as a model for all new shell plants.

Five Hagan Rotaries built and installed since 1941 have helped earn this nation-wide recognition for outstanding, economical War production. Five more Hagan Rotaries are now under construction for two other units of this organization.

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Once you start filtering your coolant with Hoffman equipment, you, too, will ask yourself, "Why didn't we do this long ago?" Hoffman coolant filtration effects large savings in maintenance, in coolant replacement, in longer life for machines, cutting tools and grinding wheels, and in fewer rejects. These are really worth-while savings that soon pay for the equipment.

● **Illustration shows typical centralized installation, designed to serve a large number of machine tools. Other Hoffman models are available for installation on single machines.**

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U. S. HOFFMAN MACHINERY CORPORATION
223 Lamson St., Syracuse, N. Y.
COOLANT FILTERS • FILTRATION ENGINEERING SERVICE

passes with light drafts of about 7% reduction until the ingot is squared to butt size. The number of passes will vary with ingot designs carrying a different taper. When the ingot is squared to butt size, the draft can be increased to as much as 20%, depending on the grade of steel. However, it is sound practice to work the first ingot of each heat continuously, even though there is no grade change, especially on a grade that is susceptible to tearing.

In isolated cases, tearing can be eliminated or kept to a minimum by blooming to butt size or recharging into the pits. This method can be used to increase the yield when difficulty is encountered on any particular heat, with slight loss in production. The process is called "saddening." This is good practice for any new or special grade when there is any doubt of the grade rolling well.

A number of experiments have been made in the processing of ingots with the view of arriving at the correct heating practice that would meet metallurgical requirements for the rolling and surfaces of billets and finished bars. The factors considered include time for bringing up to temperature, maximum temperature, soaking time, and furnace atmosphere. The practice employed will vary with grade being heated.

It has been considered desirable to bring the ingot to the mill with a fairly heavy scale which will come off easily. However, there is yet something to be learned on the nickel grades whose scale tends to cling to the ingot while rolling, forming pockets in the bloom which elongate and close up, causing surface defects.

Several methods of descaling are used on the finishing mill. Flat and edge on the first two passes after the billet is ejected from the furnace is common practice. Wire brushed on all edging passes are beneficial. High pressure water produces more satisfactory results, but the pressure should be not less than 800 p.s.i.

Excessively worn rolls will cause an undesirable finished surface. A worn flat pass used ahead of an edging pass will cause wrinkles. A worn reduction oval leading into a square will also cause wrinkles on the open corners. It is not difficult to determine the origin of these defects as they are shallow and are usually 1/8 to 1/2 in. in length.

—C. P. Hammond & A. M. Cameron. *Iron & Steel Engr.*, Vol. 21, Nov. 1944, pp. 67-73.

Spot Welding High Tensile Steel

Condensed from "Sheet Metal Industries"

Immediately after the weld has been formed, a very rapid cooling takes place which leads to the formation of martensite in spot welding high tensile steel. The weld is then reheated to a temperature below the critical by means of another shot of lower current to give a tempered martensite.

A program to determine the proper cycles was undertaken to overcome production difficulties with three steels: (1) 0.33 C, 0.8% Mn; (2) 0.18 C, 1.4 Mn, 0.4 Ni,

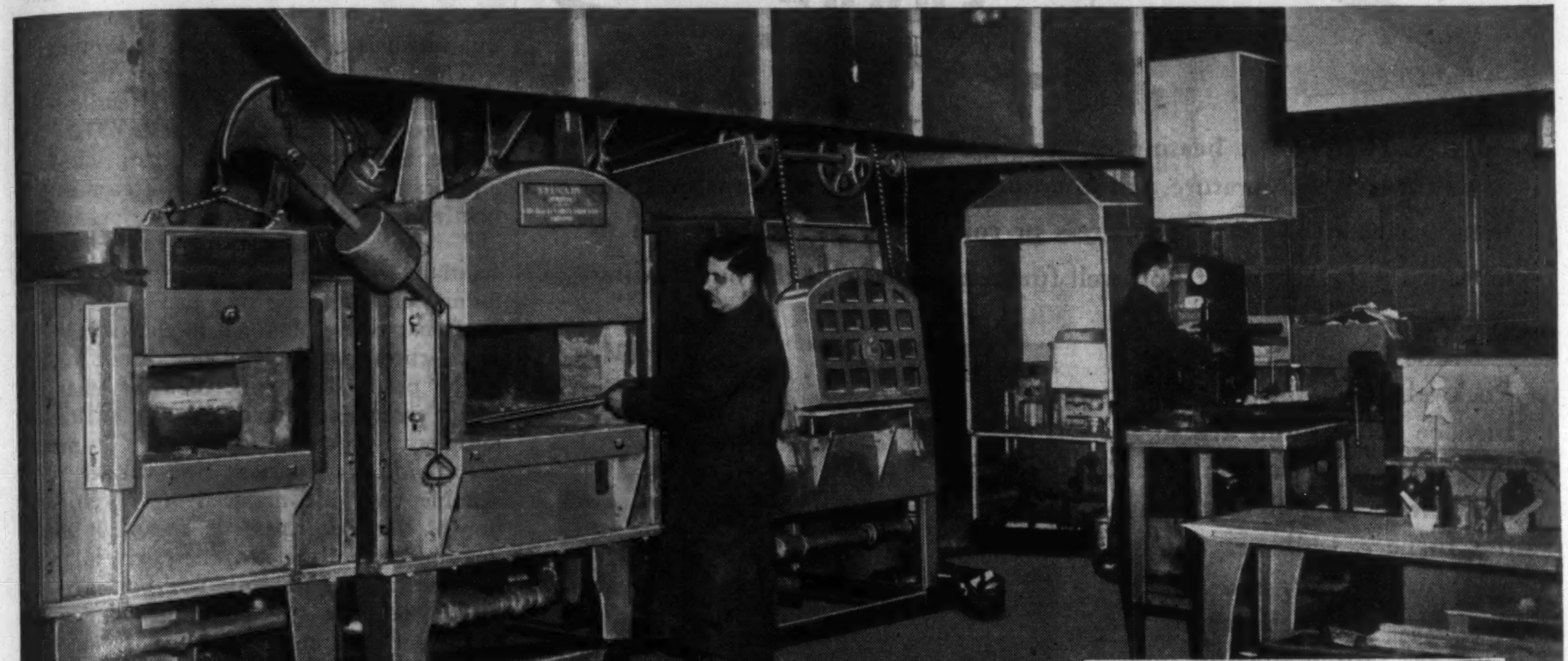
STEWART

THE BEST INDUSTRIAL FURNACES MADE

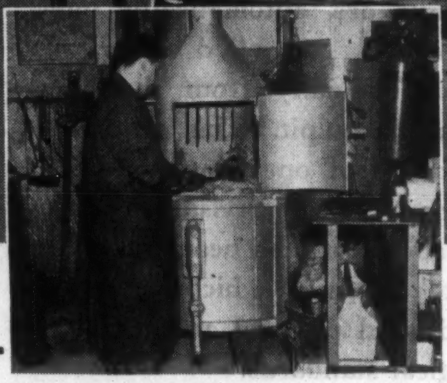
No. 56 OF A SERIES of Typical Installations

For GENERAL HEAT TREATING

at the F. L. Smithe Machine Co., Inc., New York, N. Y.



General view of the Stewart Semi-muffle Oven Furnace installation at F. L. Smithe. The furnace on the right is one of two Stewart Semi-muffle high speed furnaces with Seal-tite doors. These furnaces, with their wide temperature range and uniformity, are suited to carbon and alloy steel heat treating, normalizing, and annealing.



Stewart Round Pot Furnace for cyaniding. This particular furnace has been on the job for 30 years.

In the manufacture of open end, open side, window, cellophane and clasp envelopes, the Champion Envelope Machines made by F. L. Smithe Co., Inc., New York, must deliver a very high, continuous production. Thus the rollers, guides, cams, cutters, gears, and other moving parts used in these machines must be precision heat treated to stand up under the stresses and strains of this work. Since each part requires its own particular type of steel, it must be carefully heat treated, checked, and analyzed before and after treatment.

Flexibility has been accomplished at the F. L. Smithe Company by having a number of sizes of Stewart Semi-muffle Ovens which, with their wide temperature range and uniformity, are adapted to all types of carbon and alloy steel heat treating, normalizing and annealing. In addition, Stewart Round Pot Furnaces are available for cyaniding, case hardening, and tempering. Accordingly, a unit of correct size can be selected and easily and quickly brought to the proper temperature. One Stewart Round Pot Furnace for cyaniding small parts has been on the job for thirty years.

This installation is typical of the industrial furnaces Stewart engineers are installing every day, both large types to meet the specified requirements of manufacturers all over the continent, and a complete line of standard types such as those at F. L. Smithe Machine Co., Inc.

Heat treating a precision gear in the Stewart Semi-muffle Oven Furnace. Where flexibility is the requirement, as in general heat treating installations, these units are especially suitable.

STEWART INDUSTRIAL FURNACE DIVISION of CHICAGO FLEXIBLE SHAFT CO.

***Main Office:* 5600 W. Roosevelt Road, Chicago 50, Ill. — *Canada Factory:* (FLEXIBLE SHAFT CO., LTD.) 321 Weston Rd., So., Toronto 9**

A letter, wire or 'phone call will promptly bring you information and details on STEWART furnaces, either units for which plans are now ready or units especially designed to meet your needs. Or, if you prefer, a STEWART engineer will be glad to call and discuss your heat treating problems with you.

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If you want billet heating accurately and automatically controlled as to furnace temperature and atmosphere, and rate of transfer from the furnace to the extrusion press or rolling mill, it will pay you to investigate the record of Rockwell furnaces in some of the outstanding American Mills.

Rockwell gas, oil or electric furnace installations are so arranged that the charging cycle, movement of billets through the furnace while exposed to uniform heating, and rate of discharge and delivery to the mill are automatically interlocked, controlled electrically or manually from the operator's pulpit. This synchronization of operation gives concentrated supervision, reduces labor costs and heats the billets to a quality which meets the desired physical and metallurgical standards.

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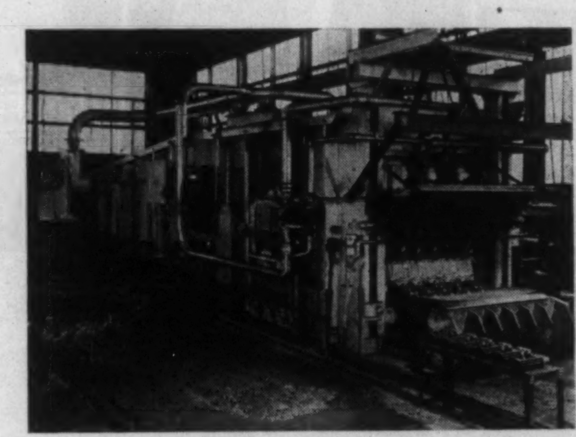
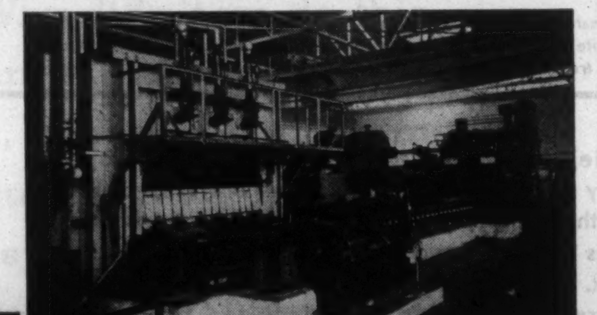
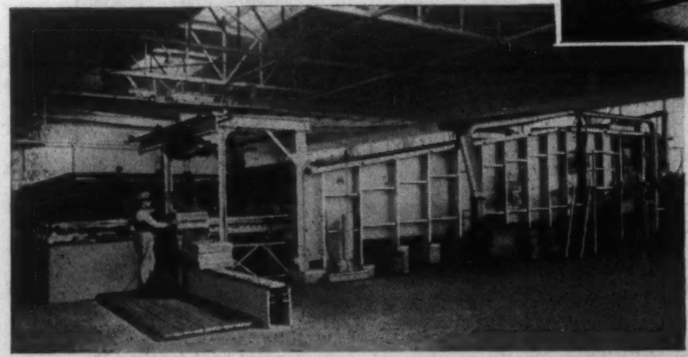


Discharge end of large Rockwell oil fired furnace for heating round billets.





Above — discharge end showing delivery table to rolling mill; all handled automatically.

Rockwell oil fired furnace for heating non-ferrous billets.

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0.25% Mo; (3) 0.25 C, 0.6 Mn, 2.7 Ni, 0.6 Cr, 0.7% Mo. Without a post-heat treatment, all welds were unsatisfactory with weld nugget hardnesses of 500, 450, and 550 V.D.H., respectively.

Provided the post-weld cooling time was sufficient to permit the formation of martensite, the properties of spot welds produced in all the high tensile steels tested were greatly improved by automatic tempering. Considerable choice of cooling time is possible, as long as it is above the minimum time required for the weld to cool to martensite forming temperatures. As the thickness of the sheet increases, longer cooling times are necessary. The tempering time must be adjusted so as to reach a temperature at which tempering may occur but which is not above the critical range.

The mechanical properties of the welds were tested by shear tests, "U" tensile tests, hardness and impact shear tests. The "U" tensile test was found to be the quickest and best quantitative test in discriminating brittle welds from more ductile ones. The "U" tensile strength of welds may be substantially increased by tempering, a maximum value of four times that without heat treatment being obtained in the case of the nickel-chromium-molybdenum steel.

For production work on steels that require post-heat treatment, consideration must be given to the following: (1) means of providing a constant line voltage; (2) suitable electrode material; (3) refrigeration of electrode tips; (4) means of selecting and controlling accurately within about ± one cycle the welding, post-heat, and the cooling periods; (5) the effect of shunting of current through adjacent welds; and (6) the effect of surface condition of the steel sheet on the welding process.

—W. S. Simmie & A. J. Hipperson. *Sheet Metal Inds.*, Vol. 20, Sept. 1944, pp. 1609-1619, 1624.

Threaded Precision Gages

Condensed from "American Machinist"

A complete line of standard gages and many special high-precision gages are now being manufactured by Kobe, Inc., Los Angeles. For threaded plug gages, SAE 52100 steel is used, blanks being roughed out on turret lathes to within 0.010 in. to 0.015 in. of finished dimensions.

First, identification markings are made by steel stamping unless thin sections are involved when pantographic engraving or etching are used, the latter if to be marked after heat treatment. Next, the blank is hardened, using oil quench, to 60 to 62 Rockwell C and aged by alternate heat and cold treatment.

Before machining, centers of the gage blank are precision lapped for accurate holding in subsequent operations. The blank is then ground cylindrically to a diam. of 0.003 in. greater than the ultimate major diam. of the finished threads of the gage. The gage body is threaded on a thread grinder, the pitch diameter being finished from 0.0003 in. to 0.0005 in. over basic size.

A finger is engaged in the thread of the gage body. During revolving, the hori-

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Brass and copper foundries everywhere report they are getting twice as many immersions since changing to Metalast Tubes. This means they are saving on their thermocouple cost as well, for Metalast Tubes are not connected to the thermocouple and can be replaced without damaging or discarding thermocouple.

Metalast Protection Tubes are made of a heat resisting alloy and will stand repeated immersions in molten brass, bronze, aluminum, copper and magnesium. Neither slag, molten metal nor contaminating gases can effect the accuracy of the thermocouple inside, since Metalast Tubes are drilled from special solid stock—without welds, seams or forging. Made for furnace or ladle use—in 6″ and 8″ lengths with standard ½″ pipe thread.

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zontal movement of the driven finger actuates a movable worktable, feeding the gage against the grinding wheel. The gage itself becoming a leadscrew, this machine is universal and can convolute any number of threads of any diameter up to 6 in.

Lapping is done in two stages: First, a specially graded diamond, or an optical lapping compound, is used; second, finish lapping is done with crystals of sapphire, extremely small but of exact crystalline form.

The gage is held and driven by a reversible two-speed, motor-driven chuck. As the gage revolves, a threaded lap, charged with compound, is held so that it engages and moves along and over the threads of the gage.

Lapping rounds the crests of the threads slightly. Cylindrical grinding reduces the major diameter of the thread to its final size. Tool marks are removed by light lapping with a cylindrical lap. Temperature in the inspection room does not vary more than 1/10 deg., humidity is kept at 40 to 45%, and dust is removed by filters and an electrostatic precipitator.

Arriving at the inspection laboratory, the gage is cleaned with a volatile solvent and examined on a measuring machine for roundness, taper, pitch and major diameters. The lead of the thread and flank angles are checked on the optical comparator. Readings are recorded on a tag which goes to the purchaser. Nitralloy may be used for gages of all types, particularly for ring thread gages.

—*Am. Machinist*, Vol. 89, Jan. 4, 1945, pp. 94-96.

Revamped Hammers Forge Tubes

Condensed from "Steel"

In the manufacture of bombs by Tennessee Enamel Mfg. Co., Nashville, Tenn., seamless steel tubing, purchased in desired length and gage, is heated in specially designed oil-fired forging furnaces to about 2200 F. and is forced into the dies of power-hammers for forming nose and tail by manually-operated wheel and screw devices. Automatic mechanisms rotate the tubing continuously. Power-hammers were converted from punch-presses.

Nose and tail are cut off with acetylene torches to proper length. Suspension lugs are then welded to the body in proper position. Following this, the nose is drilled, bored, faced, undercut, and chamfered in large drill-presses, using specially developed combination quick-change tools.

A specially designed hydraulically operated lug testing-machine tests the strength of the lug welds in three directions. While in this machine, the nose machining operations are gaged.

The bombs are heated to about 1600 F. in a continuous-flow, oil-fired, muffle-type furnace. After thorough soaking, the pieces are quenched in water to about 400 F., removed from the water, and allowed to cool in the air to room temperature. Then they are drawn by heating to 1100 F. in oil-fired and electric box-type porcelain-enameling furnaces.

The bombs are pickled in 10% sulphuric

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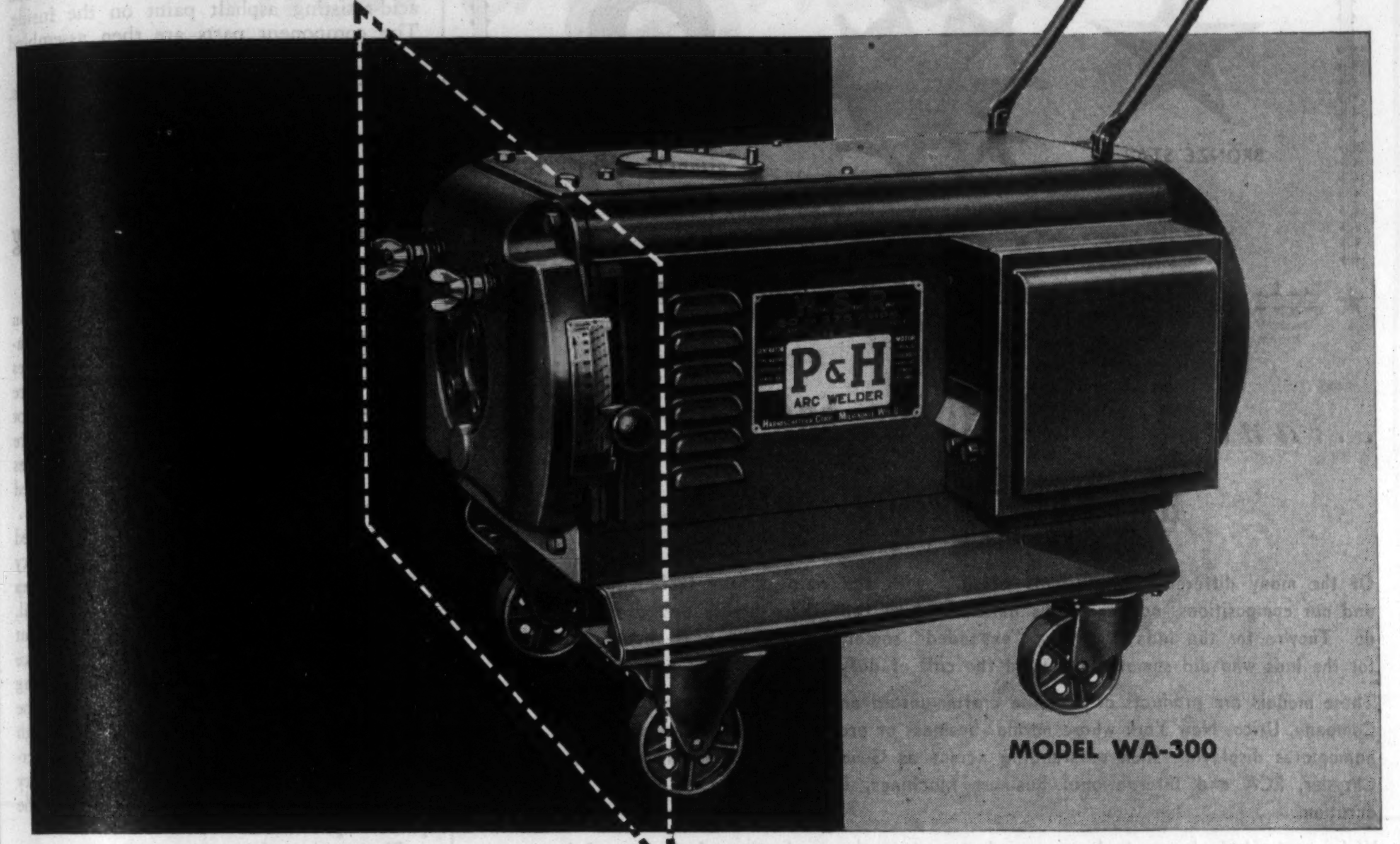

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NOW—all the unique advantages of P&H's Square Frame design (and some new ones, too!) are brought to you in a welder of larger capacity.

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A single control provides any desired welding heat within the machine's capacity. WSR (Welding Service Range) ratings give you the actual usable welding current the machine will deliver from minimum to maximum. "Visi-matic" calibration enables you to select, instantly, the right current for each of the three classes of electrodes—high, medium, or low voltage.

If your work falls within a range of 60 to 375 amperes, it will pay you to get all the facts about this new P&H Model WA-300. Write for Bulletin No. W-59.

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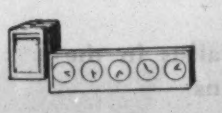
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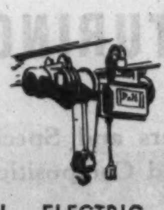
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We're particularly happy to have a modest part in the production of these medals and are displaying them because (1) they are different and (2) you may have a troublesome finishing problem somewhat similar.

American Emblem Company has this to say about LEA Compound: "It eliminates stain spots, excellent for deburring, gives better control of grain, achieves faster cutting, eliminates drying, and assures a uniform finish."
. . . advantages which apply equally well to the company's peace-time products such as these nameplates.

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acid, sand-blasted, and inspected for welding cracks and surface cleanliness. Then nose threading is done in large drill-presses, and the tail section is machined and threaded on turret-lathes.

Final inspection and gaging are then performed, with pieces being inspected 100% on all major dimensions. Any weld spatters or tube defects are removed by chipping and grinding. The piece is cleaned and painted with primer on the outside and acid-resisting asphalt paint on the inside. The component parts are then assembled to the bomb.

—*Steel*, Vol. 116, Jan. 8, 1945, pp. 92, 94, 96.

Medium Frequency Induction Hardening

Condensed from "Stahl und Eisen"

Surface hardening by the induction method is now finding extensive application in Germany. Ultra high frequencies (50,000 to 2,000,000 cycles per sec.) are used if the depth of hardening must not exceed 1 mm. or if thin-walled pieces are to be hardened, but medium frequencies (600 to 10,000 cycles per sec.) are used for hardening depths of 1 to 30 mm.

The depth of hardening can be adjusted by choosing appropriate current frequency and intensity or by varying the air gap between the surfaces and the induction coil.

Induction hardening can be carried out by simultaneously heating the entire surface and quenching it as a whole or by heating and quenching individual portions of the piece by moving either the piece through the coil or the coil over the piece. In certain cases, a combination of a stationary closed heating coil with rotation of the piece is preferred.

Two series of tests, one with stationary and one with progressive heating, were carried out to determine the influence of rate of heat input and heating time upon the temperature distribution in the cross-section of the piece. As direct measurement of temperature was not considered reliable, temperatures above the Ac_3 were determined by local grain size measurement. Temperatures below Ac_1 were determined by hardness measurements. In both cases, the standards were determined in separate tests.

For any one heat input rate, the temperature gradients are exponential curves. The steepness of the upper curves increases with rising heat input due to the combined action of a rising skin effect with increasing current density and the shorter heating time which reduces the amount of heat diffused into the interior.

The danger of overheating the surface increases with the rate of heat input, but such overheating can be avoided by an appropriate choice of heat input and heating time. Experimental determination of required heat input and time is necessary in order to meet various requirements of case depth and hardness.

Temperatures in excess of the specified hardening temperature can be tolerated within certain limits since the rapidity of induction heating tends to diminish the danger of grain growth.

CUTTING NEW HIGH-SPEED FIGURES
18-4-1
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It out-classes the old traditional 18-4-1 steels in all important points: it out-cuts and out-lasts, assuring bigger, more consistent production; it performs with ease. All this at a lower cost.

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"Americans"

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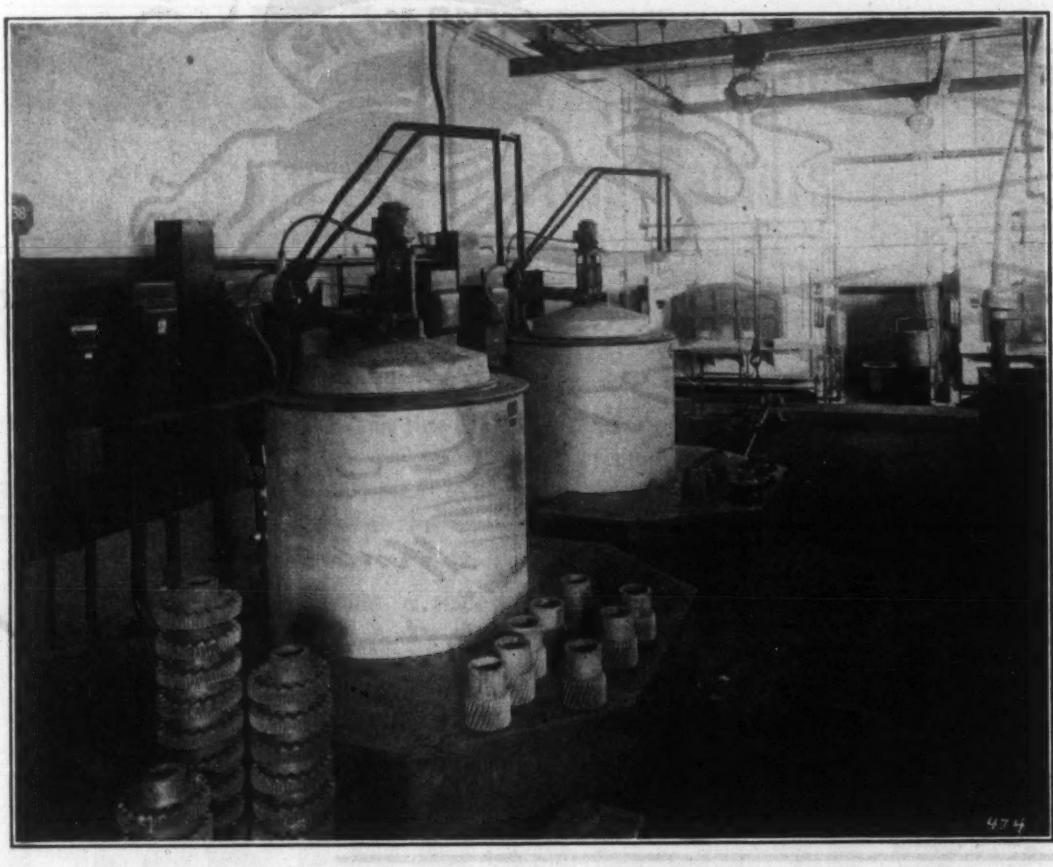

"AMERICAN" Electric Furnaces at SNOW-NABSTEDT GEAR CORP., New Haven, Conn., are meeting the close tolerances and exacting requirements of their War and Peace Time production.

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The Model NA Air Tempering Furnaces and the Model B Furnaces for carburizing and hardening are shown above. Other AEF Furnaces are used for salt hardening.

American Electric Furnace Company
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Industrial Furnaces for All Purposes

The attainable hardness for a number of standard German steels varies with the composition (mainly with the carbon content). Furthermore, the degree of hardness that can be obtained is a function of the original structure, as the finer the grain size prior to hardening the easier it is to reach the upper limit of the hardness range.

The width of the transition zone will depend upon the temperature distribution, the latter being governed by the coordinated values of heat input and heating time chosen.

—G. Seulen & H. Voss. *Stahl u. Eisen,* Vol. 63, Dec. 23, 1943, pp. 929-935; Dec. 30, pp. 962-965; as abstracted in *Engineers' Digest* (American), Vol. 2, Jan. 1945, pp. 27-30.

Subzero Treatment of High-Speed Steel

Condensed from a Paper of the American Society for Metals

The various drills of molybdenum-tungsten high-speed steel used in the tests were made from round stock of conventional sizes. After heat-treatment, they were finish ground to size. All drills were produced with as uniform a shape as possible. Heat treatment was usually carried out in salt bath furnaces. Hardening temperatures ranged from 2000 to 2240 F.

Quenching was done in oil, salt, air or a lead-tin bath with automatic temperature control. Temperatures down to minus 120 F. were obtained in a commercial chilling unit of the cascade type, while liquid nitrogen was used for temperatures of minus 310 F.

To obtain an overall comparison between heat treatments involving subzero cooling and regular heat treatment, performance data for six different groups of tests involving a total of 1078 grinds, or a measure of performance based on average inches drilled per grind, have been summarized. This gives a picture of the effect of subzero cooling interposed in the heat treating cycle before and after single tempering and in conjunction with multiple tempering.

For a standard, 100%, were assumed the results by normal heat treatment and without subzero influences. The best performance rated 110%. Here there was subzero cooling down to minus 120 F. after single tempering at 1040 F. for 1 hr. This checked with torsion and hardness tests, which showed that this treatment gave physicals equal to or very slightly better than those obtained with normal heat treatment.

The second best average performance rated 103% where multiple subzero cooling was interposed in the heat treating cycle before, after or between multiple tempering.

Continuous cooling to minus 120 F. from a hardening temperature of 2200 F. results in the subzero transformation of at least 95% of the amount of austenite that would transform if cooled to temperatures as low as minus 310 F., it was concluded. The formation of additional martensite during subzero cooling after hardening gives an increase in specific volume, hardness and strength as compared with normal hardening.

The increment of hardness and strength gained by subzero hardening is maintained up to tempering temperatures of at least

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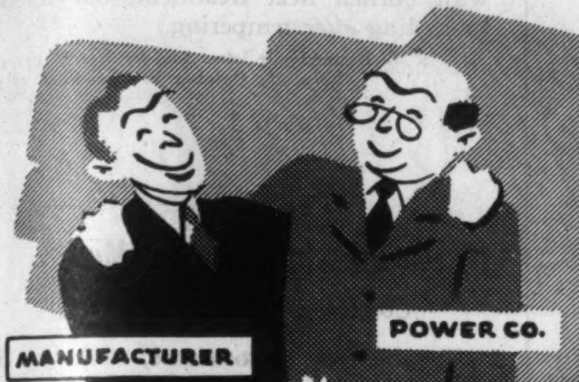


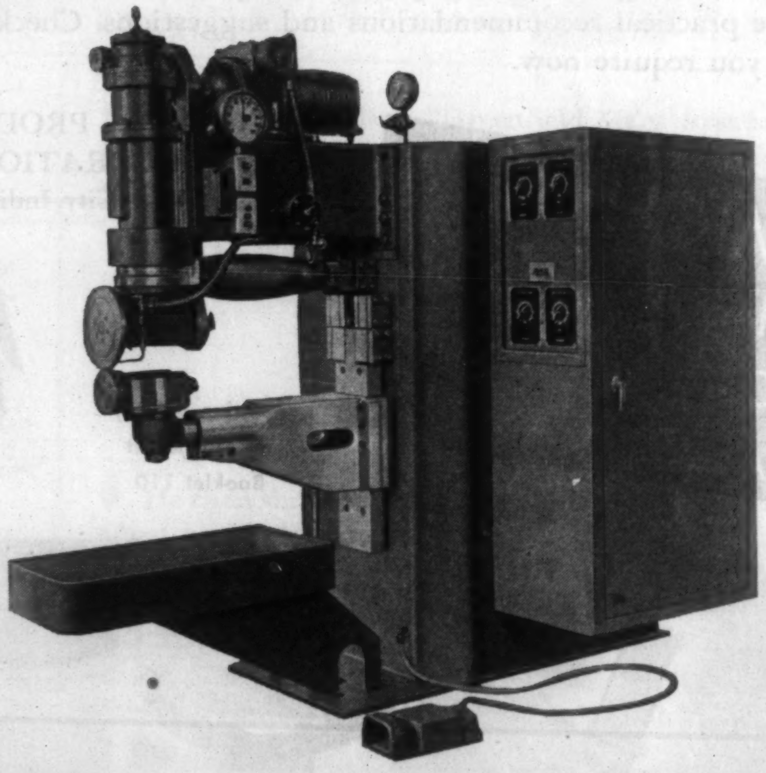
"THREE-PHASE"

Manufacturers and power companies have long been at odds over the problem of supplying power for heavy reactive loads. Particularly in the case of heavy duty resistance welding of steel, power suppliers have often found it necessary to place a ***demand charge*** on the manufacturer.

One reason for this is that conventional welders must utilize the comparatively high frequency alternating current in their secondary circuit. High frequencies mean high reactance, with resultant operation at very low power factor — often 25% or less. Low power factor means more current must be available to meet the same demand . . . often requiring a boost in the size of distribution facilities.

Sciaky "THREE-PHASE" welders are designed to overcome this, as well as other difficulties encountered in heavy duty resistance welding. An ideal low frequency current is produced at the electrode tips by an ingenious system of first, rectifying all three phases of the supply to d.c., then reconverting to an alternating impulse. Operation is on a ***balanced three phase load*** at ***near unity power factor.***

Bulletin 204-A describing fully the Sciaky "THREE-PHASE" principle will be gladly sent on request.



The Sciaky THREE-PHASE principle has been effectively applied to heavy gauge seam welding. The machine illustrated (type PMM.2T-13) welds steel up to two thicknesses of .109" and can achieve a speed of 84" per minute on two thicknesses of .040". Transformer rating is 120 KVA at 50% duty cycle. Unit is entirely self-contained with hinged side mounted rectifier and control cabinets. Electronic controls provide adjustable on-off time, squeeze and hold time.

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Heat Resistant and Corrosion-Resistant

800 F., but at 1040 F. it has disappeared. Subzero hardening followed by tempering 1 hr. at 1040 F. decreases plasticity, compared with normal hardening.

Subzero hardening after the above tempering produces little change in hardness, strength, or plasticity when hardening temperatures of 2200 F. or higher are employed. At lower hardening temperatures, the cooling after tempering yields some increase in hardness and strength, and a marked increase in plasticity.

Subzero cooling *before* tempering at 1040 F. gives tool performance equal to that with normal heat treatment, but inferior to cooling *after* tempering.

—R. G. Kennedy, Jr. *Am. Soc. for Metals*, Preprint No. 28, October 1944 meeting, 44 pp.

Dies for Punching Mica

Condensed from "Machinery"

Trouble-free performance, with low die maintenance, can be attained in punching natural or fabricated mica, provided proper consideration is given to the inherent characteristics of mica during the design of the dies. Runs of a half-million strokes between grinds can be maintained, with some runs of a million strokes experienced.

Natural mica is obtained in sheets, and has a shear strength of 18,000 to 38,000 p.s.i. Both natural and manufactured mica are highly abrasive, tend to flake, crumble and powder when worked.

The tool steel for punches and dies is the most important factor for efficiency. The most satisfactory steel is an oil-hardening tool steel, 0.90 C, 0.30 Si, 0.30 Mn, 1.6 Cr, 0.45 W and 0.10% V, with a hardness of 62 to 63 Rockwell C. The cutting edges and faces of the punch and die should be ground and well polished so as best to resist abrasion. The higher the polish or smoothness, the less the abrasion. When resharpening the punch and die, all scores must be removed.

The die stripper should have a maximum clearance of 5% of the material thickness on a side. The stripper should be good oil- or air-hardening tool steel, hardened, ground, and well polished, having sharp edges. Then edges of the punching will be true and square, with no flaking during removal from the die.

Inadequate support of the punching close to the cut edges allows flaking during its removal and the top edges of the punching tend to break away and the flakes set up an abrasive action between the punch, die and stripper. They eventually fill the cavity between the punch plate and the stripper.

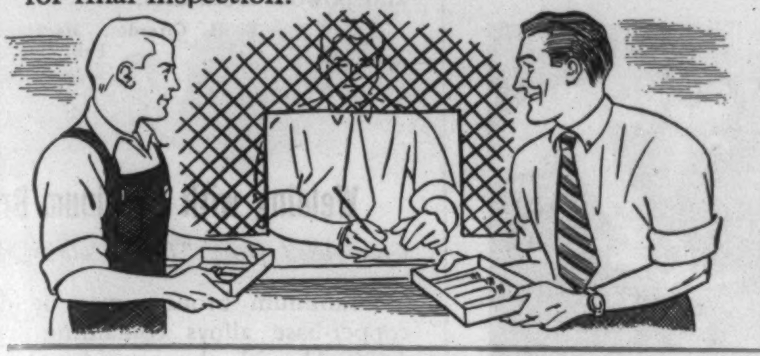
When a soft stripper is used, abrasion rounds off the edges of the stripper, regardless of amount of clearance, again allowing excessive flaking of the punching. With progressive dies, used for manufactured mica only and run in presses with roll feeds, spring-type strippers are used, made from machine steel with hardened tool steel inserts around the punches.

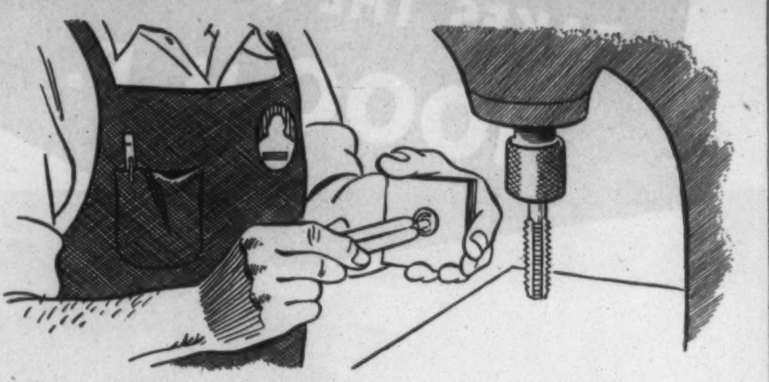
Pilots should be of water- or oil-hardening tool steel, hardened, ground, and well polished, preferably with vertically polished surface rather than rotary. Material guides

NOTHING WRONG WITH "REJECTED" PARTS?
"GREENFIELD MAN" SOLVES GAGING MYSTERY

[A GTD SHOW-HOW REPORT]

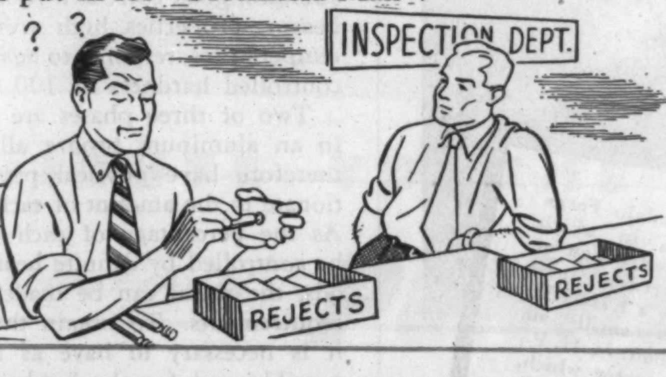
1 Customer ordered six 1/2-20 "Go" plug thread gages made to "X" pitch diameter tolerances. Three of them were assigned to machine operators as working gages and three to inspection department for final inspection.

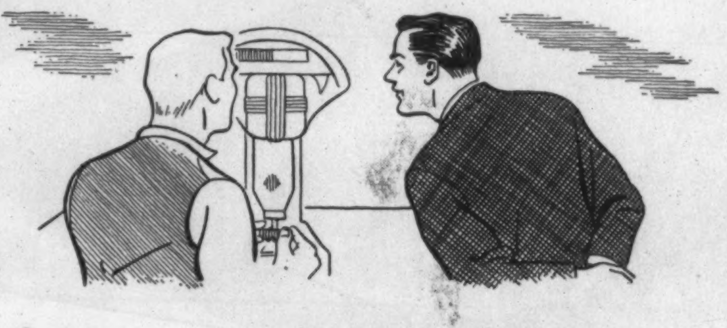




2 At tapping job the machine operators used working gages to check each part before they went on to next operation.

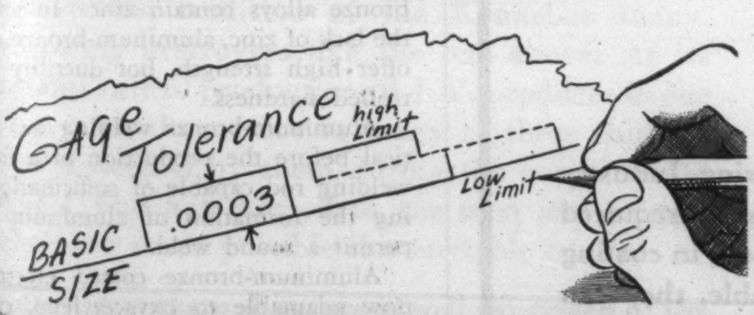
3 But at the final inspection of part, a large proportion of pieces failed to pass "Go" plug gage. Why? Actual measurement of rejected parts showed them to be "OK". Something was wrong. A hurry call was put in for "Greenfield Man".

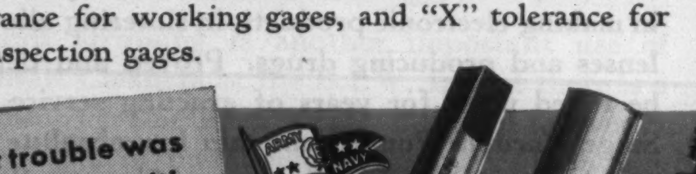




4 On arrival at plant, "Greenfield Man" first had all six gages measured in customer's own inspection department, and found them all within tolerance.

5 "I'll show you what happened," said "The Greenfield Man". "Although all six gages were within specified limits, some were on the 'high side' and some on 'low side'. Thus high limit gages failed to enter where low limit gages would."





6 He then showed how this problem could be remedied by: 1. Measuring all gages and distributing those that tended to the "high limit" to machine operators and those tending to the "low limit" to the inspection department. 2. By ordering "Y" tolerance for working gages, and "X" tolerance for inspection gages.

Results: (1) Customer learned that trouble was not with gages he ordered, but with their application to the job. (2) Was able to establish proper gage ordering and handling procedures.

"Greenfield" SHOW-HOW is KNOW-HOW in action!

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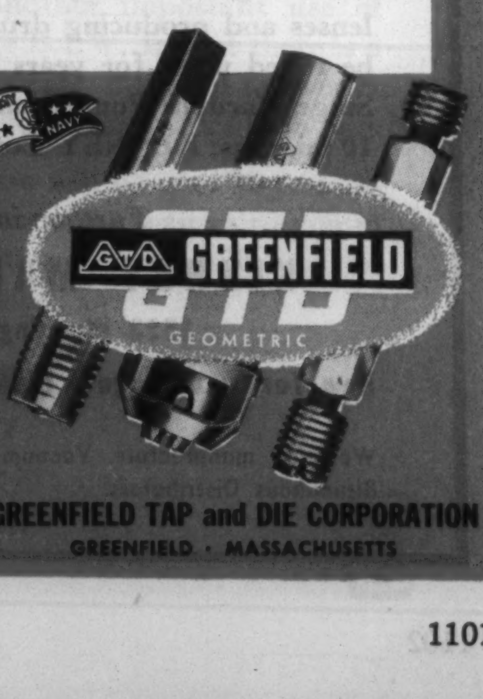
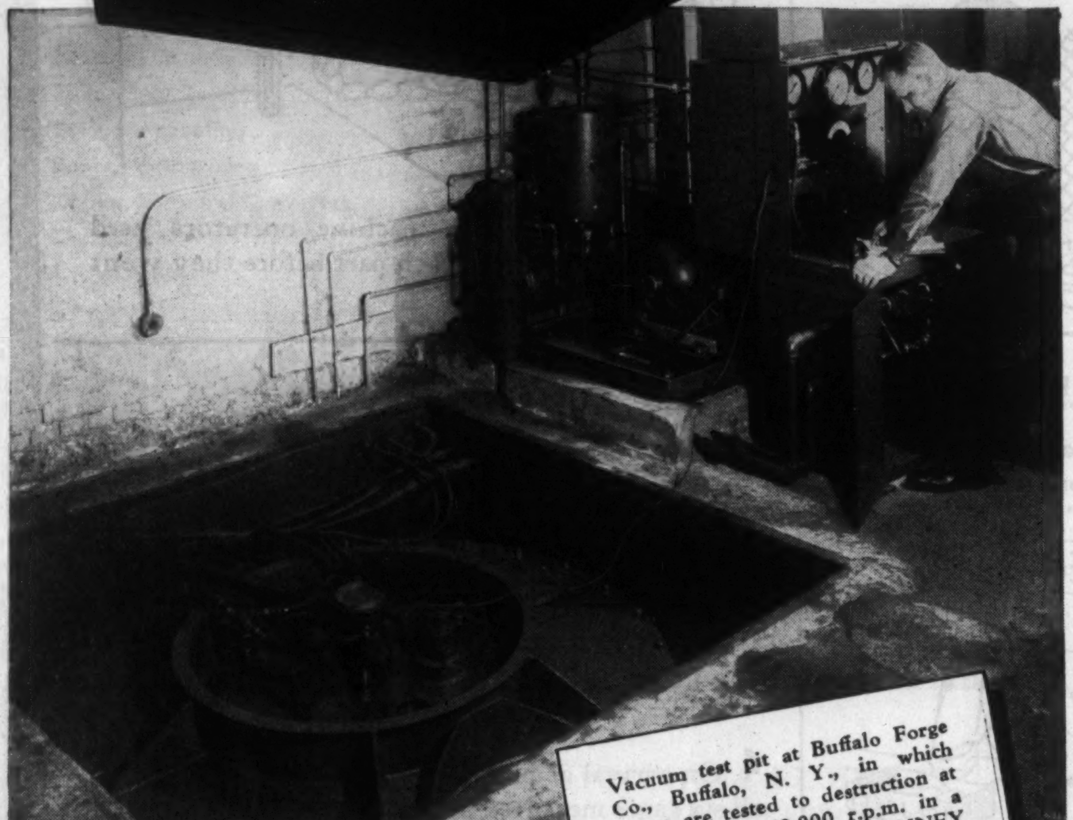


GREENFIELD TAP and DIE CORPORATION
GREENFIELD · MASSACHUSETTS



1/4 H. P.
TAKES THE PLACE OF
1000 H. P.

Vacuum test pit at Buffalo Forge Co., Buffalo, N. Y., in which rotors are tested to destruction at speeds up to 60,000 r.p.m. in a vacuum maintained by a KINNEY Vacuum Pump. A small air turbine, developing about 1/4 H.P., actually revolves the rotor which, under normal atmospheric conditions, would require a 1000 H. P. motor.

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should be of water- or oil-hardening tool steel, hardened and the work sides ground. Clearance between punch and die should be 4% of the material thickness on a side. Increased clearance gives a tearing rather than shearing action.

Sectional dies are preferable to solid ones on high production operations, provided the size and contour of the punching is suitable. It is imperative that die sets be used, preferably the more accurate center post or four-post sets used for intricate work or high production operations. No lubricant should be used. Air blast will remove flakes and powder from dies.

—E. H. Girardot. *Machinery,* Vol. 51, Feb. 1945, pp. 142-145.

Welding with Aluminum Bronze

Condensed from "The Welding Engineer"

Aluminum bronzes may be defined as copper-base alloys containing from 5 to 14% Al with the possible addition of a maximum of 5% of a third element, such as iron, manganese or nickel. This article is confined to those containing iron. The outstanding characteristics of the aluminum bronze family are high tensile and impact strength, good corrosion resistance, excellent bearing properties, high strength at elevated temperatures, response to heat treatment, and controlled hardness of 100 to 350 Brinell.

Two or three phases are usually present in an aluminum bronze alloy, which will therefore have physical properties proportionate to the amount of each phase present. As the percentage of each constituent can be controlled by definite heat-treating methods, the metal can be made to fill varying requirements. To obtain the softest range, it is necessary to have as much alpha as possible and for the harder, as much beta and delta.

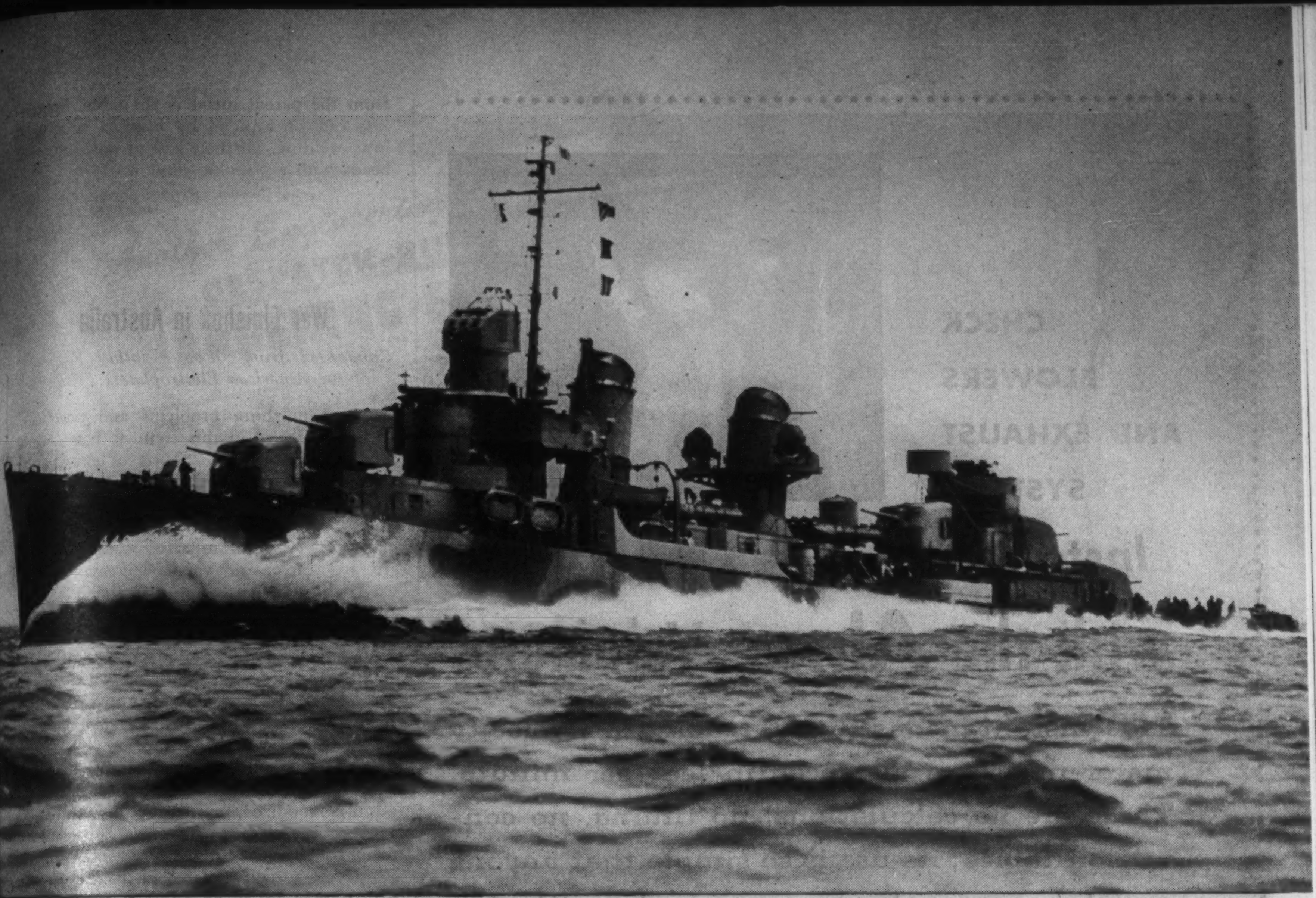
Prior to the appearance of aluminum-bronze electrodes, no high-strength welding rods of bronze alloy were available, for one reason because several of the high-strength bronze alloys contain zinc. In addition to the lack of zinc, aluminum-bronze electrodes offer high strength, hot ductility and controlled hardness.

Aluminum-bronze welding was not practical before the production of a flux-coated welding rod capable of sufficiently preventing the formation of aluminum oxide to permit a sound weld.

Aluminum-bronze coated electrodes are now adaptable to oxyacetylene, carbon-arc and metal-arc welding. Oxyacetylene welding is sometimes quite difficult because the aluminum oxide is refractory and hard to flux. For carbon-arc welding, where direct current is used with straight polarity, the electrode should be of material made specifically for that purpose.

Deep penetration of the base material is not desirable. For metal-arc welding, using direct current with reverse polarity, approximately the same arc lengths and current ranges are used as with mild-steel electrodes, although the operation is different.

In all bronze welding, cleanliness is necessary and moisture should be avoided. Particularly in overlay work, deep penetration should be avoided, as a minimum of dilution



A TRIBUTE TO THE BATH IRON WORKS

from the makers of PENNSALT CLEANERS

REG. U. S. PAT. OFF.

● The first ship built in America, the "Virginia," was launched from the shores of the Kennebec in 1607. The Bath Iron Works Corporation is carrying on the tradition of the Kennebec today, launching destroyers like the one above. At its present rate of production, B.I.W. produces in one year more than twice as many of these ships as were launched by them during the entire World War I. Our hats are off to the men and women who have made possible this enviable record.

How fine these ships are is well expressed in the following extract from a letter written by the commanding officer of the destroyer pictured above:

"A word of praise for the grand job the Bath Iron Works did on the ship. She has been through h—l and high water and never failed us. Keep on building ships as fine as this . . . We have put on nearly one hundred and fifty thousand miles and she is as good as new."

We of Penn Salt are proud of the small part we are privileged to play in this outstanding achievement.

Galvanized work on these ships is first cleaned with a Pennsalt Cleaner to insure a finish which will withstand the extreme corrosive conditions of the sea.

Paint stripping is another important use of Pennsalt Cleaners at the B.I.W. In fact there is a Pennsalt Cleaner scientifically designed for nearly every type of metal and maintenance cleaning.

Our chemical engineers will be glad to demonstrate the benefits of Pennsalt Cleaners to you in your plant. No obligation. Write fully to our Special Chemicals Division, Dept. MA

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This instantaneous direct reading air velocity meter measures air speed in feet per minute. There are no calculations, no timing, no conversion tables; its use is so simple that anyone can take accurate measurements with the Velometer. Extension jets permit correct readings in many locations that would be difficult or impossible to reach with other means of measurement.

Keep exhaust equipment working efficiently by regular checks for draft, leaks, blower operations, etc., with the Alnor Velometer. You can get accurate information on performance with a few minutes' inspection at regular intervals.

The Velometer is made in several standard ranges from 20 fpm to 6000 fpm and up to 3 inches static or total pressure. Special ranges available as low as 10 fpm and up to 25000 fpm velocity and 20 inches pressure. Write for Velometer bulletins.

Velometer used for positive static pressure readings

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from the parent metal is advisable. Spatter loss can be avoided by using a relatively low welding current and depositing the beads with a weaving motion.

—Roy Norton. *Welding Engineer*, Vol. 30, Jan. 1945, pp. 48-51.

War Finishes in Australia

Condensed from "The Monthly Review" of the American Electroplaters' Society

Metal finishing problems and practices in Australia, as in this country, have been affected by the war. Shortages exist, and many metals and supplies are controlled by the government.

The use of nickel is limited to defense purposes. Chromium salts, cadmium and tin are scarce, and vapor degreasers, such as trichlorethylene, are unavailable. Replacement of equipment is difficult. The labor problem is acute. Women workers are used, and hours of employment are long.

Most of the war equipment produced must be carefully treated to protect it from corrosion, since the corrosive conditions on the South Pacific battle fronts are severe.

The types of treatment used are, in general, similar to American practice. Aluminum is anodized, mostly by the chromic acid process. Zinc-base die castings are treated with the Cronak process. Copper alloys are usually plated with nickel or tin. If they are to be used in contact with aluminum, cadmium over tin is used.

Cadmium is universally used to protect steel. A humidity test is usually applied to cadmium plated parts, but salt spray or salt immersion tests are sometimes used. Cadmium-plated parts that are to be painted are bonderized or parkerized to obtain good paint adhesion.

—B. M. Armstrong. *Mo. Rev.*, Am. Electroplaters' Soc., Vol. 32, Jan. 1945, pp. 27-31.

Prepared Atmospheres for Heat Treating

Condensed from "Industrial Heating"

The heat treating department that is fully equipped to handle all of the heat treating operations involved in the manufacture of tank drive assemblies is notable for the economy of space effected by careful layout and for the use of a prepared atmosphere in all the heat treating furnaces operating in the higher temperature range.

Propane is the gas used as fuel throughout the plant. In order that a prepared atmosphere for the prevention of scaling and decarburization can be used in the heating chamber, a number of the furnaces are heated with gas fired radiant tubes, namely, a continuous pusher type furnace used for the heat treatment of spline shafts; five box type furnaces used in heat treating operations above 1300 F.; six box-type furnaces used for hardening operations on a variety of parts; and three rotary hearth furnaces used for hardening.

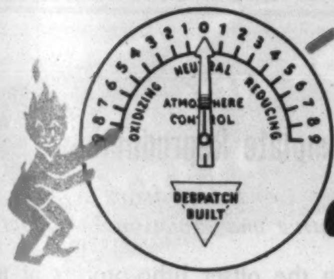
In addition, gas fired radiant tubes are used in the six bell type furnaces for gas

Another Engineering Hit!

DESPATCH-BUILT
HARDENING FURNACE

DESPATCH BUILT

Despatch Hardening Furnace (gas-fired), 36" wide, 60" long and 18" high inside.



with Dial
COMBUSTION CONTROL

Just turn this dial! It's as simple as that to control combustion in this new Despatch-engineered Hardening Furnace. You get *reducing, neutral* or *oxidizing* atmospheres by moving the indicator on a large graduated dial which is connected to a special metering valve.

MAKES IT EASY TO DUPLICATE TREATMENT

Developed by Despatch engineers, this valuable feature eliminates the slow, ticklish job of readjusting air-gas proportional mixers for different heat treatment processes. Now you can easily and quickly duplicate *any* previous combustion condition right on the nose.

Added to the many *other* important features which make Despatch Hardening Furnaces engineering *hits,* this simple control means boosted output, more efficient processing, easier operation and lower heat treatment costs. ***Available in all popular sizes.***

OTHER TYPICAL FEATURES

UNIFORM HEATING results from an efficient combustion system with multiple burners manifolded to mixer. Burners are staggered and mounted under and over hearth; vents are at hearth-level. This assures fast, uniform heating and more complete combustion. No flame impingement.

•

KINETIC FLAME CURTAIN is promptly thrown across door opening to form effective heat and air seal. Prevents air infiltration.

•

POSITIVE DOOR SEAL. Heavy, non-warping counterbalanced door descends below hearth level and snugly seals door opening on all 4 sides. Easy-working with Despatch "roller-rest" door locks.

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RUGGED CONSTRUCTION of extra heavy steel.

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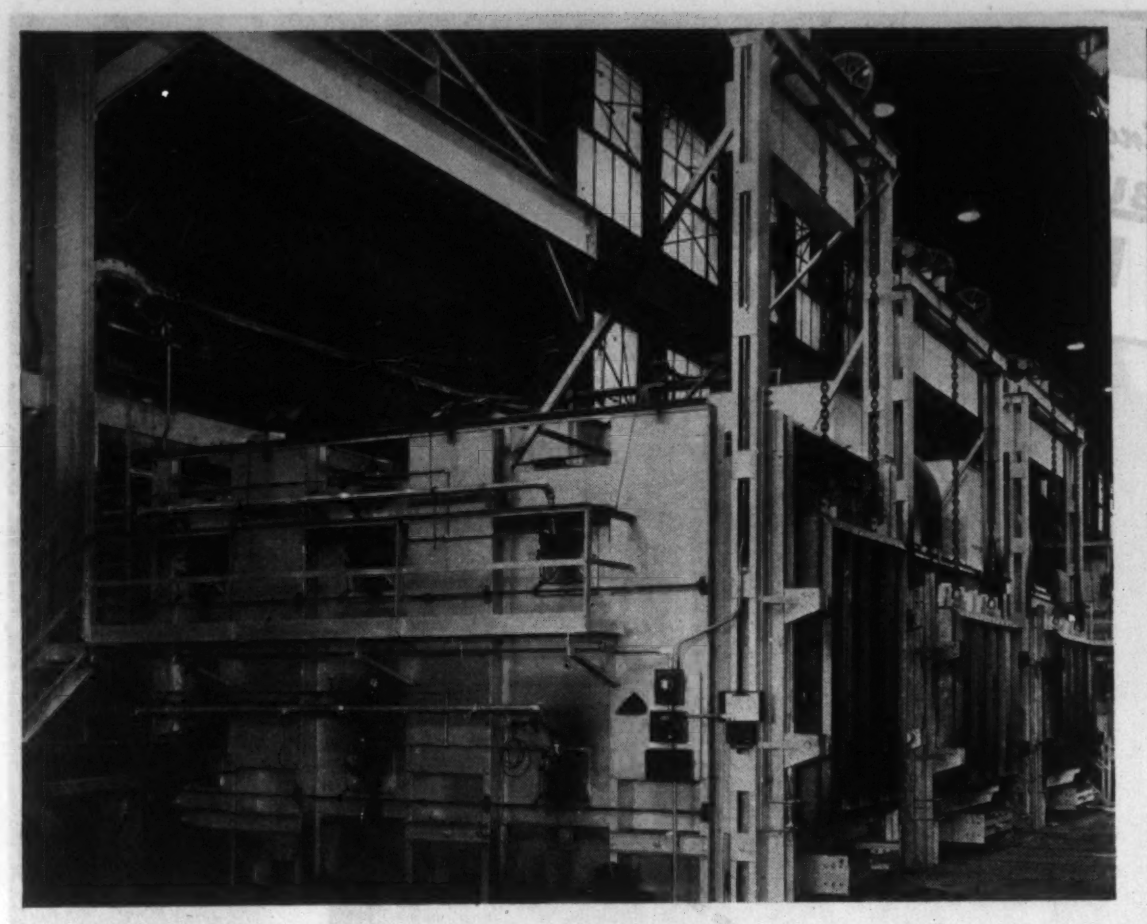


VULCAN Furnaces

For Fast, Accurate Heating and Heat Treating Operations

The battery of three Car Hearth Furnaces illustrated above is typical of all VULCAN installations in advanced design, efficient, high-speed heat treatment, and economical operation and maintenance. Used for handling miscellaneous forgings and weldments, they are oil fired, with complete automatic control in two zones. Temperature uniformity of 10° plus or minus is readily maintained. Cars and doors are motor operated. Doors are equipped with air operated clamps for sealing.

Furnace No. 1, in foreground, is direct fired and used for annealing and normalizing at maximum temperature of 1700°.

Furnaces No. 2 and No. 3 are convection heated and are used for normalizing at temperatures up to 1250°. Each is equipped with two high temperature fans.

An imposing list of installations demonstrates the important part allotted to VULCAN Furnaces in the Nations' war effort, and of the high measure of success attending it.

Although each VULCAN installation is engineered to meet specific requirements, the cost is generally no greater than for standardized equipment. Let us quote on your requirements.

VULCAN CORPORATION
1791 CHERRY STREET, PHILADELPHIA, PA.

carburizing. In this case, the atmosphere consists of a mixture of 6.5 cu. ft. of propane to every 100 cu. ft. of prepared gas atmosphere to give a case with 0.95 to 1.00% C.

There are one double unit and three single unit gas generators used to supply the large requirements for prepared atmospheres. The prepared atmosphere is then piped to the individual furnaces where it is to be used.

Other furnaces include two gas-fired continuous pusher type normalizing furnaces, five box type recirculating furnaces for use at temperatures not exceeding 1300 F., a car type stress relieving furnace and three continuous conveyor recirculating type furnaces for tempering. In addition, the department has a gas fired combination lead pot and salt bath furnace and an electrically heated salt bath furnace for liquid carburizing of tools, etc.

Two flame hardening machines are used for the hardening of sprocket teeth. These units are equipped with conveyors that carry the sprockets through the entire cycle of treatment. There are also four flame hardening machines for hardening turret rings, which are subsequently stress relieved in the car type furnace.

Quenching tanks are located adjacent to their respective furnaces. The temperature of the oil is controlled automatically. A quenching press is used to minimize distortion in the quenching of shafts. There are also five quenching machines for the distortion free oil quenching of tank transmission gears.

Finishing equipment includes three straightening presses of the hydraulic type and two table type shot blasting machines for the final cleaning of finished gears.

—Ind. Heating, Vol. 12, Jan. 1945, pp. 19-20, 22, 24, 26, 28, 30, 32, 34-36, 38, 104.

Template Reproductions

Condensed from "Automotive and Aviation Industries"

Utilizing the offset litho-process of template reproduction developed by Consolidated Vultee Aircraft Corp., mirror-image patterns are produced from loft layouts. Although not foolproof, it produces good results and saves time.

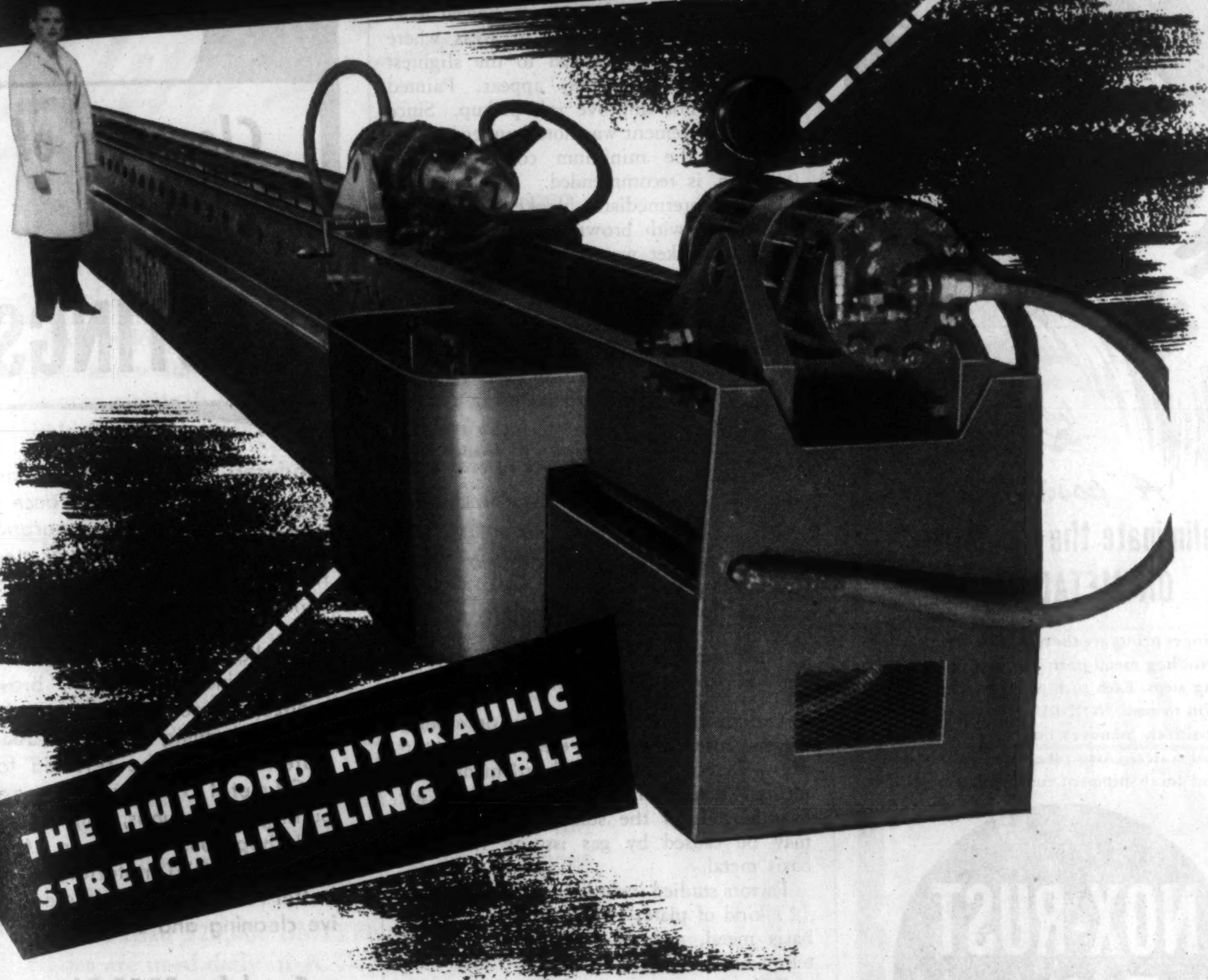
Loft-scribed plates are inked to provide the initial pattern, then a rubber-covered roller is rotated over the plates so as to pick up the inked pattern. The pattern is transferred to a blank sheet of metal, and when the ink is dry, the duplicate template can be cut from the metal.

But this method failed to solve the problem of mirror-images in its initial form. An "intermediate blanket," which is actually a rubber-faced pad, was finally used. A blanket was used to pick up the pattern from the scribed original; then, from the blanket the pattern was transferred to the rubber-covered roller and blank sheet of metal in the usual manner. Images are not as clear as by the original offset method, but they are consistently adequate.

In testing by contact, the scribed original was fastened to the press bed and inked in the usual manner. Clean metal was placed over the original and the press cylinder

FOR *RAPID-FIRE* STRAIGHTENING AND STRETCH-FORMING

of extrusions . . . rolled stock . . . narrow sheet!



THE HUFFORD HYDRAULIC STRETCH LEVELING TABLE

THE HUFFORD Hydraulic Stretch Leveling Table quickly, easily *and permanently* straightens and levels those long, narrow metal sections that are twisted, bent or otherwise distorted when they come from the forming rolls or heat treat —puts them in shape for forming or degreeing operations to follow, facilitates stacking and handling!

Engineered for heavy-duty work, the shape, size or length is no problem with the Hufford. It handles sections up to 40 feet long, of any shape and many materials. The ends of the work are gripped in the jaws of two opposing tension cylinders, hydraulic tension is applied at one cylinder, and the resulting "set" established by stretching the work straightens and levels it on all dimensions. Close control can be maintained over applied tension . . . the machine can be equipped with an automatic stop for definite percentage of stretch . . . various work lengths can be accommodated on the one machine . . . uniform parts are produced . . . complex extruded or rolled shapes are easily handled.

STRETCH-FORMS TO 30 DEGREES

The Hufford Stretch-Leveling Table is so designed that it can be used in conjunction with dies for stretch-forming long workpieces that require contours up to 30 degrees . . . thus is *doubly* valuable for all types of fabricating operations such as railroad car building, bus and truck body construction, shipyard use, etc. Extensively used in aircraft construction for stretch-forming long fuselage stringers, etc.

If yours is a straightening or stretch-forming problem, send today for Engineering Bulletin A-3 which gives more complete details covering construction and operation of the Hufford Hydraulic Stretch Leveling Table, including specifications. No obligation, of course!

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NOX-RUST
No. 310-AC

A "positive" to eliminate the "negative" ON METAL PARTS

Finger prints are the negatives left after handling metal parts between processing steps. Each such print is an invitation to rust. NOX-RUST No. 310-AC positively removes both finger prints and water. (Also ideal for inter-plant and local-shipment rust prevention.)

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rolled over them. Sufficient ink was transferred to produce a usable mirror-image reproduction, providing the original was perfectly flat.

A second method included laying intermediate blankets of various materials over the original and rolling. Materials were then removed, turned over, and replaced. The press cylinder was again rolled over the blankets, this time picking up the ink impression and transferring it to the metal on the other press bed.

Results obtained by contact showed weak background densities, and in areas where the original is oil-canned to the slightest extent blank areas may appear. Painted stock did not improve ink pickup. Since little improvement was noted under varying pressures, the minimum compression of 0.015 in. is recommended.

With intermediate blankets, reproductions made with brown paper as an intermediate blanket was promising. A mirror image was made with the offset blanket cemented to a sheet of 0.015 in. by 3 ft. by 5 ft. Paintlok produces the best density background.

Compression of 0.015 in. was required for good density background using a dense offset black ink.

—C. F. Reupsch. *Automotive & Aviation Inds.*, Vol. 91, Dec. 1, 1944, pp. 26-27, 62, 64.

Defects in Electroplate

Condensed from "Proceedings" of the American Electroplaters' Society

Experiments were carried out on a study of gas-caused defects in electroplated coatings. Defects such as embrittlement, blistering, non-adherence, and pitting are examined from the standpoint that these may be caused by gas issuing from the basis metal.

Factors studied included: (1) basis metal, (2) kind of plate, (3) method of cleaning basis metal, and (4) effect of time and temperature of aging.

Following are some of the observations and conclusions: Silver and zinc plated on SAE 1020 steel that had been cleaned cathodically in 70% sulfuric acid developed severe brittleness after heating or aging. When the steel was cleaned anodically, no brittleness developed. Nickel as a basis metal gave results similar to steel. Zinc plated on electrolytic iron that had been cleaned cathodically in sulfuric acid developed only a trace of embrittlement on aging 24 hr. This is explained by the fact that pure iron absorbs a minimum of hydrogen gas.

The observations were confirmed by a study of blistering. Zinc plate on cathodically cleaned steel blistered on heating to 250 F. immediately after plating, or on aging 24 hr. at room temperature. The extent of blistering increased with the severity of the cathodic treatment. Anodically cleaned specimens did not blister.

The results described are explained as follows: Hydrogen enters the basis metal as a consequence of its discharge on the surface during cathodic treatment. On heating or on aging the work, the hydrogen escapes from the steel, in some cases enter-

War-Developed
OAKITE MATERIALS
SPEED
Cleaning of
DIE
CASTINGS

Producers and users of die castings know the high importance of CORRECT surface preparation before applying organic or other finishes either for corrosion prevention or appearance.

Since die castings may be of aluminum, zinc, magnesium, brass, bronze, copper, tin or lead, the RIGHT cleaning or degreasing material should be selected for EACH metal to thoroughly remove buffing compounds, oil, grease and shop soil. Because in EACH case, the RIGHT material assures better results, faster, more effective cleaning and LOW unit cost.

Send for FREE Digest

Producers and users of die castings are invited to take advantage of the wide range of specialized Oakite materials designed for cleaning die castings, and of our 35 years' successful experience in this work. A new Oakite Digest discusses this important subject, describes cost-cutting methods used by many plants. Write for your FREE copy today.

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Specialized cleaning
MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

Picture of Man Doing the *Impossible*

No one had ever built a 6000-ton mechanical press. But war needs demanded one. Then the engineers found that the orthodox cast columns with tie rods wouldn't do the job.

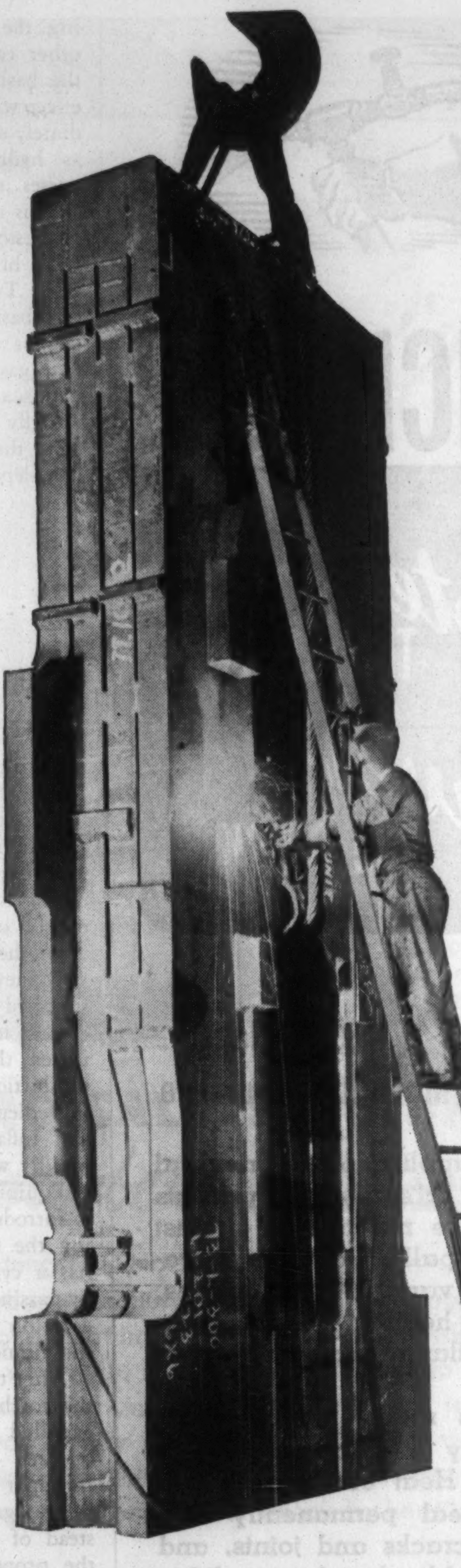
But, making each column of four 6″ thick steel plates and welding them together proved practical. Greater strength with less elongation under load could then be had at a 25% saving from cast steel construction.

The only problem was what electrodes and welding technique to use so as to prevent breaking the welds or buckling the 70-ton columns in the subsequent heat treatment required.

A. O. Smith welding engineers worked out a special technique and specified SW-35 electrodes for the first passes of each weld and SW-20 for all the finishing passes. It worked—"the impossible" was done!

The complete success of this unique welding job is evidenced by the fact that this 6000-ton press is now turning out critical war forgings 24 hours a day.

More than 320,000 SMITHway Certified Electrodes are used daily in A. O. Smith plants alone. They have helped many industries advance by making the most of welding as a modern production tool. Write for catalog.



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SMITHway Welding Monitor trains better welders, faster.

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Saves The BRICK

• Forms a Highly-glazed Vitrified, Monolithic Surface

A simple application of Brickseal with brush or spray gun, protects your furnace refractories against cracking, spalling and deterioration due to variable temperatures, differential heating, corrosive vapors, and flame abrasion.

Furnace is ready for operation immediately after application of Brickseal. Heat of furnace vitrifies Brickseal permanently into all pores, cracks and joints, and forms a highly-glazed, monolithic coating. Brickseal cannot crack, peel or blister due to sudden temperature variations because it remains semi-plastic until furnace cools.

Write for sample or Brickseal representative, today.

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ing the plate and embrittling it, and in other cases forcing the plate to lift from the basis metal, thus causing blisters. This effect will cause plate that is ductile immediately after plating to "age" into brittleness as hydrogen leaves the basis metal and passes into the plate.

It is noted that for some reason not fully understood, one side of the test panels always blistered much more than the other side. Two per cent beryllium-copper alloy as a basis metal exhibits the same phenomena as steel. The hypothesis is advanced that gas pitting of electroplates caused by "unusually adherent" hydrogen bubbles may actually be caused by hydrogen gas exuding from the basis metal rather than by hydrogen deposited directly from the electrolyte.

—Carl A. Zapffe & C. E. Faust. *Proc.*, Am. Electroplaters' Soc., June 1944, pp. 93-108.

New Silver Soldering Technique

Condensed from "Steel Processing"

In the usual method of silver soldering, the tendency is to use an excess of flux. This results in discoloration and accumulation of residue, requiring special cleaning, grinding, and buffing to remove all traces of the residue. A second effect is the generation of porosities by the gases emanating from the volatilized flux.

A new method, in which the flux is supplied automatically to the joint in the correct amount and at a uniform rate, eliminates these difficulties and gives faster production. Properly compounded fluxing ingredients are dissolved in a highly volatile and inflammable liquid, which evaporates rapidly when exposed to the air.

Equipment consists of a container, which is introduced into the fuel-gas line supplying the torch. The head of the container has a cylindrical valve for regulating and by-passing the flux. The interior contains a cotton wick, which is kept saturated with the liquid.

After turning on the fuel-gas and opening the torch valve to allow all the air to be expelled from the system, it is ready to operate. The fuel-gas picks up the flux in vapor form and delivers it to the torch in the gas. The flux is in the flame, instead of on the rod or on the work, and the proper amount to use is obtained by adjusting the flux regulating valve.

The vaporized flux in the fuel-gas stream imparts a brilliant green color to the flame, which tends to mask the inner cone. All adjustments of the torch are made while wearing welding goggles, which should be fitted with green lenses. Final adjustment of the torch should be made to give a mild brush-like flame.

The foregoing procedure is perfectly satisfactory for butt fillet joints. With lap and press-fit joints, it is necessary to supplement the flame fluxing action with a paste silver solder flux. The latter should be applied in only sufficient quantities to cover the surfaces requiring capillary action. In the tube-within-a-tube type of joint, the paste flux should be applied carefully and lightly to the female part of the joint.

—C. A. Medsker. *Steel Processing*, Vol. 31, Jan. 1945, pp. 34, 38.

SILVER BRAZING ALLOYS

RINGS and WASHERS for all brazing jobs

ANY QUANTITY
ANY SHAPE
ANY SIZE

Also Strip, Coiled Wire, and Filings.

Available in standard alloys covered by Federal Government, Army, Navy, Air Corps and A.S.T.M. specifications.

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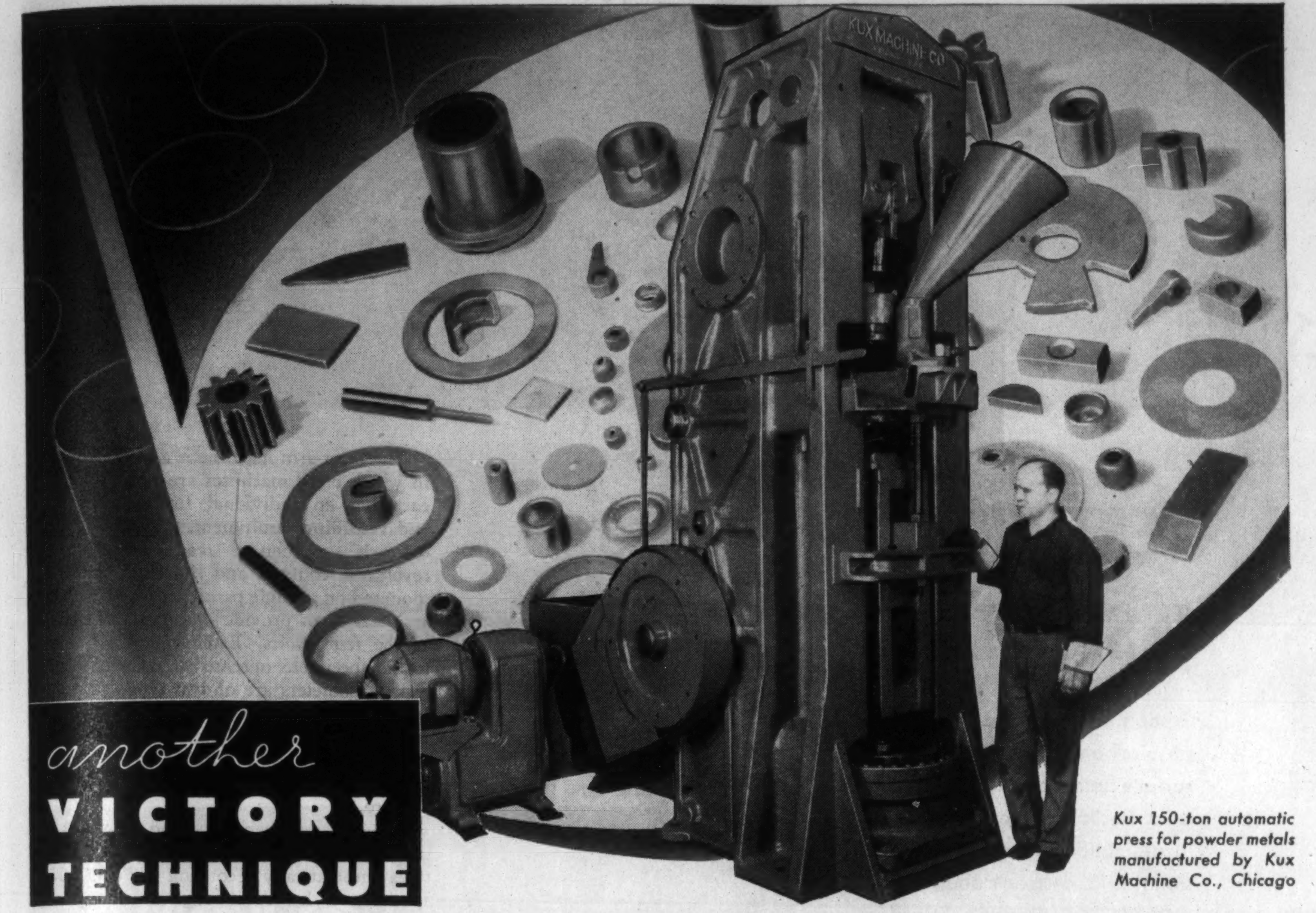


another
VICTORY TECHNIQUE

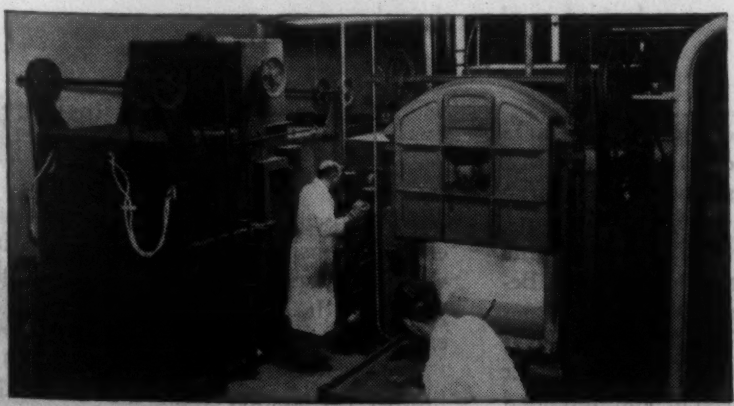
Kux 150-ton automatic press for powder metals manufactured by Kux Machine Co., Chicago

A NEW NOTE IN THE METALLURGICAL SYMPHONY... *Powder* METALLURGY

BEFORE the ancients worked with molten metal they fabricated simple implements from metal powder. Yet it was not until the vast needs of World War II that the development was forced to practical proportions. Now thousands of parts pressed from powdered metals and sintered in a controlled atmosphere furnace are being used in weapons of war and accessories at a great savings of time or cost or both.

One order of 40,000,000 small parts was produced for the navy at the rate of 520 pieces per minute by powder metallurgy. A piece of Ordnance from powder metal effected a saving in cost of about 70%. And the same story applies to a vast multitude of parts from powdered iron, bronze, aluminum, silver, tungsten, platinum.

Powder Metallurgy is one of the many Victory Techniques that have infinite postwar possibilities and about which you must learn if you are to meet competition. Your Lindberg representative is eager to help you in any possible way. Discuss with him the new developments in powder metallurgy, sintering, brazing, and treatment of metals by heat in any form.



A Battery of Lindberg Brazing Furnaces in operation

LINDBERG ENGINEERING COMPANY
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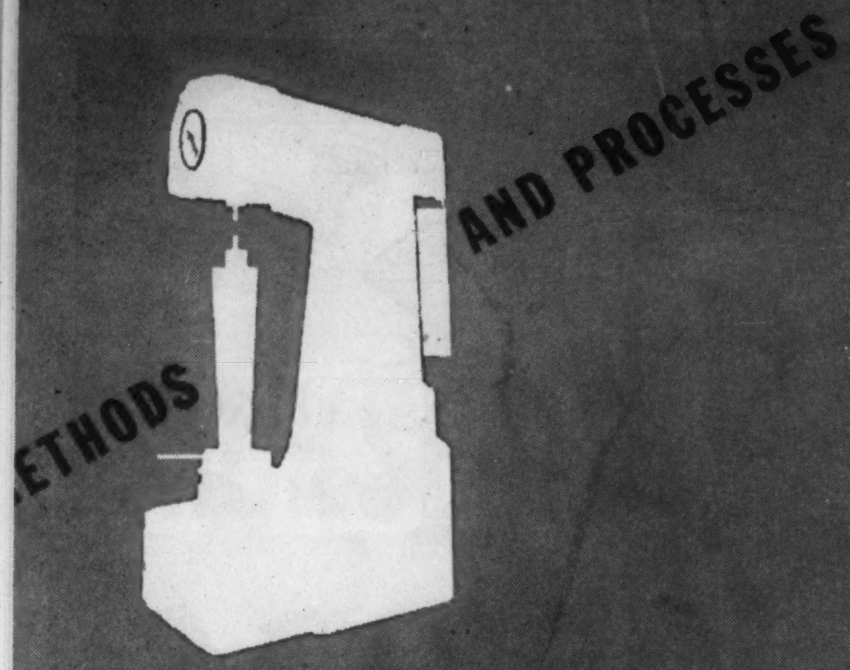
ARMY E NAVY

Lindberg FURNACES

SUPER-CYCLONE for hardening, normalizing, annealing, tempering
CYCLONE for accurate, low-cost tempering and nitriding
HYDRYZING for scale-free and decarb-free hardening



TESTING and INSPECTION

Testing methods and equipment for physical and mechanical properties, surface behavior and special characteristics. Radiographic, spectrographic, identification, metallographic, dimensional and surface inspection. Stress analysis and balancing. Specifications, standards and quality control.

New Creep Test Devices

Condensed from "Transactions" of the American Society of Mechanical Engineers

To meet the present need for testing equipment for determining the high-temperature properties of new alloys, Westinghouse Research Laboratories has developed two new creep-test instruments. These are intended especially to evaluate alloys used in furnace construction. For this work allowable strains may be rather large, and the creep-to-rupture test was selected as the most suitable means of evaluating these materials.

For this test, the specimen is held at a constant load and temperature, and allowed to elongate until rupture occurs. At high loads this may require only a few hours, while at somewhat lower loads the time may extend to several thousand hours. Because of this difference in time, two types of machines were used, one using the lever arm principle and intended for the longer tests, the other screw-driven, and intended for the shorter tests to rupture.

The lever-arm machine is a multiple unit, in which eight machines are combined, but each has an individual furnace, controls, and recording equipment. The elongation of each specimen is read directly by a revolution counter, and the eight counters, mounted on a single panel, are photographed at intervals to provide a continuous record of the test results. Extensometers attached to the specimens operate the counters.

Extensometers are of two types, one giving readings in hundred-thousandths of an in. over a 3-in. gage length, used for small strains up to 2%, another recording in ten-thousandths of an in. for strains up to rupture.

The screw-driven machine provides a continuous elongation-time curve up to rupture, automatically recording the data. The specimen is loaded through a stiff spring, and no extensometer is used. While the machine has a capacity of 10 tons, it occupies a floor space of only 15 in. by 15 in.

If used with an extensometer, the machine can be adapted to relaxation tests also. Without the extensometer it is suitable for short-time tensile and constant strain-rate determinations.

In the lever-arm machine the specimen is loaded through a 20:1 lever arm, weights being applied at the end of the arm. The maximum load is 600 lb., giving a stress of 60,000 p.s.i. for a standard specimen. The screw-driven machine consists of a stiff spring in series with the specimen, and a screw-driven jack for loading the spring. The load is maintained by keeping a constant deflection of the spring.

Readings are taken by measuring the motion of the upper head of the machine relative to the frame. Both load and temperature are held constant.

—**M. J. Manjoine.** *Trans.*, Am. Soc. Mech. Engrs., Vol. 67, Feb. 1945, pp. 111-116.

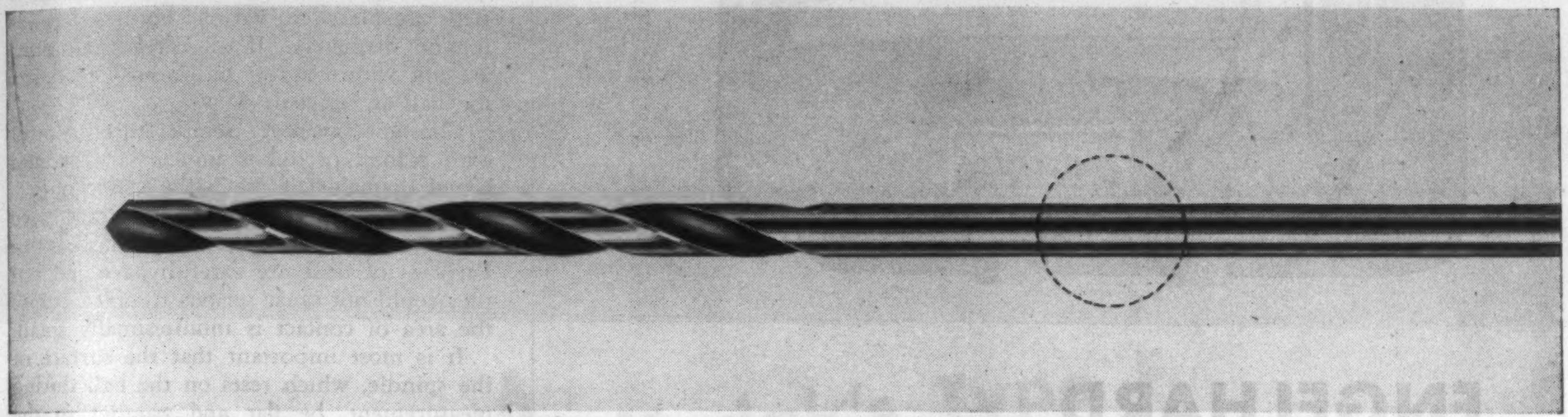
Measuring Balls for Bearings

Condensed from "Machinery"

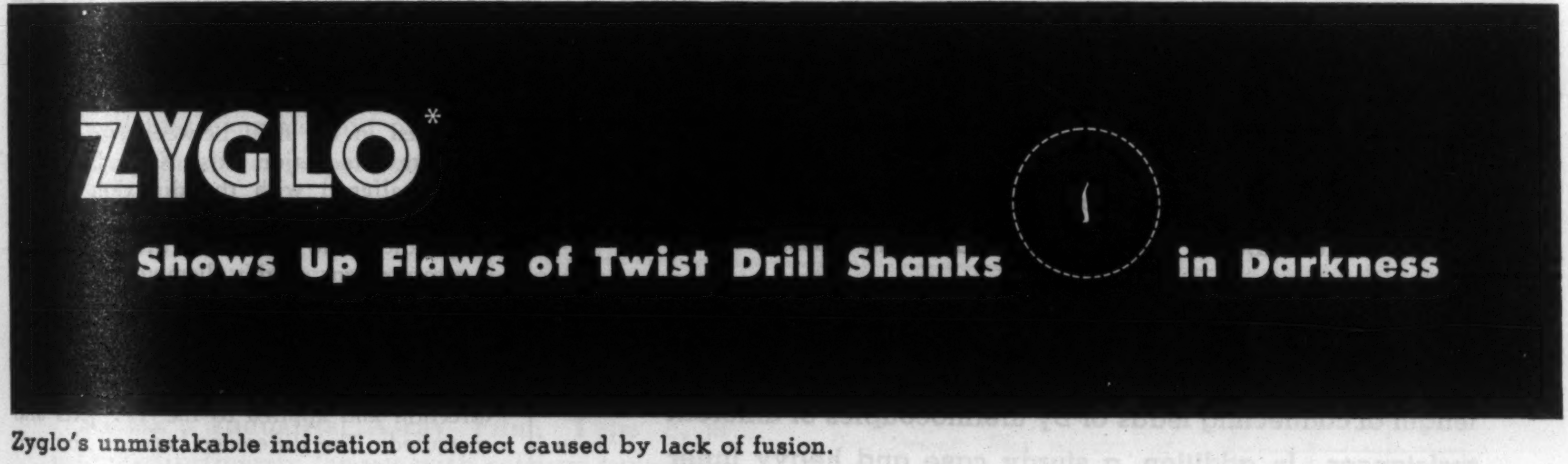
In gyroscopic flight instruments the basic element consists of a small mass rotating at very high speed, running as smoothly as possible. It dictates rotor bearings with extremely low and uniform friction torques.

If one steel ball in a bearing is 30 millionths in. smaller than the others, it assumes no load, while the other balls assume

By Modern BLACK MAGIC



Normal white-light picture of a high-speed twist drill with oil-tempered extension shank flash-welded to it . . . no flaw visible.



Zyglo's unmistakable indication of defect caused by lack of fusion.

The best time to discard an imperfect flash-welded drill, like that illustrated above, is before it breaks in use—with possible injury to operator and probable damage to the part in process. This calls for 100% pre-service inspection of every weld—careful, accurate inspection by a method which *reveals clearly* what the unaided eye cannot see.

ZYGLO's brilliant fluorescent penetrant indications unfailingly locate *and show up* such dangerous defects in all welds…lack of fusion, cracks, etc.

ZYGLO Inspection, fast enough to keep step with production, may be adapted successfully to all types of welds—in both magnetic and non-magnetic metals.

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**ZYGLO—The Trade Mark of Magnaflux Corporation applied to its equipment, material and methods for fluorescent penetrant inspection.*

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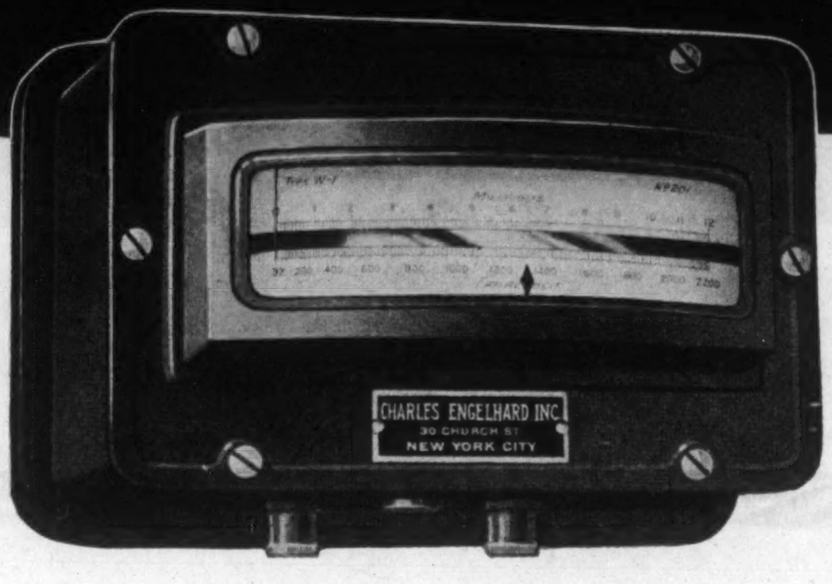

ENGELHARD

INDICATING PYROMETERS

Despite severe operating conditions, the Engelhard Switchboard model (above) responds with delicate sensitiveness to variations of 55/1,000,000 of one volt in order to show temperature changes of 10° F! Accuracy is assured by a high resistance per millivolt that is unaffected by the length of connecting leads or by thermocouples of different resistances. In addition, a sturdy case and heavy inner construction provide permanent efficiency for unusually difficult services.

Readings by direct deflection are made simply and *instantaneously* in either millivolts or temperatures. This model can be calibrated with two ranges for one type of thermocouple, or for two types of thermocouples in any combination desired. It is provided with a zero adjustment device to allow setting for ambient temperature variations.

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90 CHESTNUT ST., NEWARK, NEW JERSEY

35% more than normal. Measuring instruments must therefore have a precision of one-millionth in.

Measurements of diameter and spherocity are done by an Electrolimit gage, measuring the specimen ball with a standard reference. The operator picks up the reference ball from a bottle with special insulated tweezers that will not conduct the heat of his body. It is placed in the hole of a holder plate that allows moving the ball around under the spindle of the gage.

Controls must be adjusted to a definite reading for the reference ball, which is of average and known dimensions. The spindle is lifted and the ball moved to measure a second diameter reading; then a third. The procedure for measuring other balls is the same except no adjustments are necessary. Balls are placed in various bottles, depending on diameters. If all three indications are not within a few millionths of an in., the ball is rejected.

Constant average temperature control over a long period is unnecessary because actual diameter of the balls is not important as long as all balls in one race have the same diameter within a few millionths. Particles of dust are carefully avoided but they could not cause serious trouble because the area of contact is infinitesimally small.

It is most important that the surface of the spindle, which rests on the ball during measurement, be flat and parallel to the optical flat used on the anvil. The ball may be deformed during measurement by 60 millionths of an in., but if the same for each ball, it is inconsequential.

To measure out-of-roundness of a ball, it is placed in the field between two Alnico magnets. Its major axis, X-X, is immediately aligned with the direction of the field. The X-X axis assumes a position perpendicular to the face of the spindle and a measurement of this diameter made. To measure the minor diameter, Y-Y, the ball is attracted to a small diameter soft iron rod.

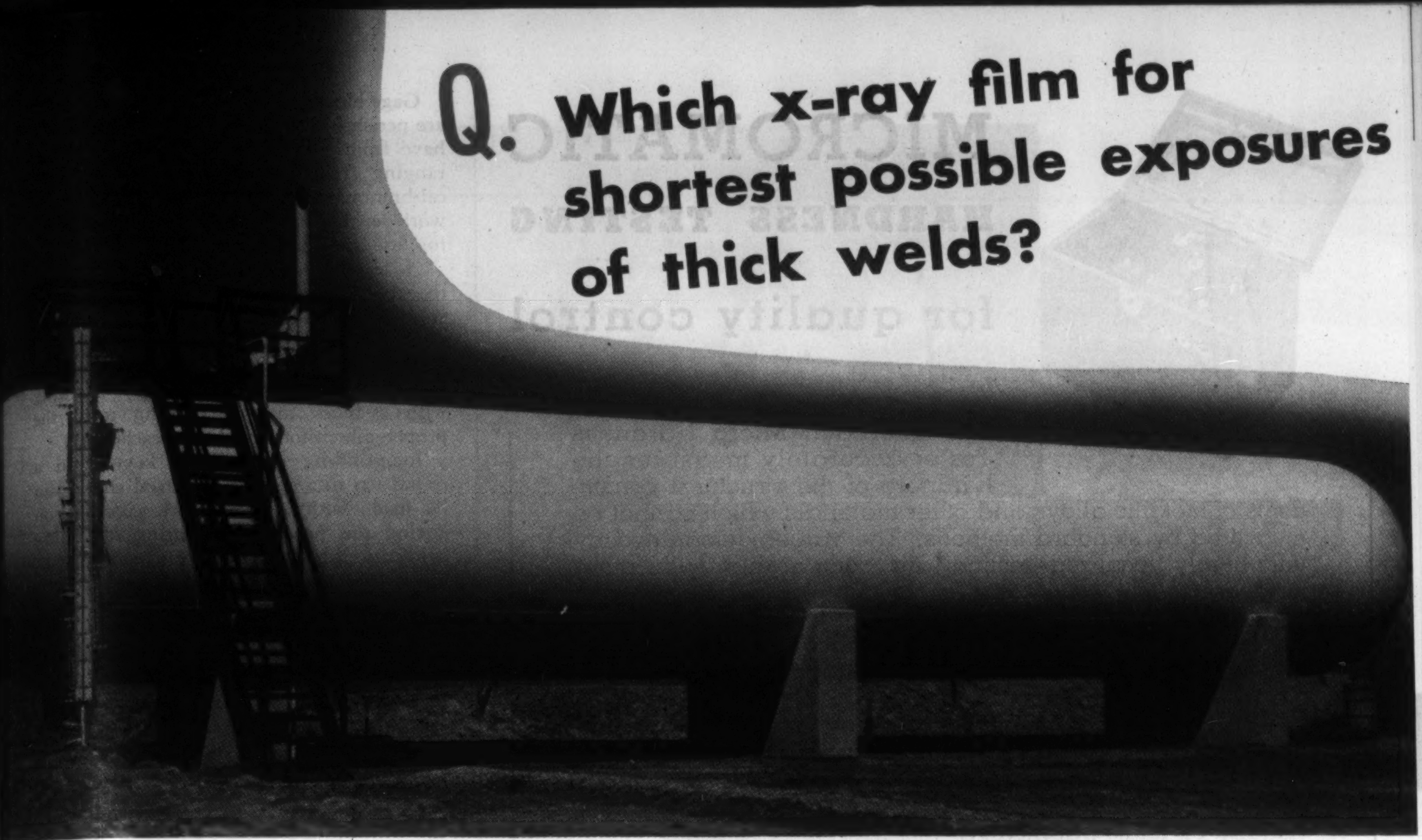
Magnetism is removed from the X-X direction and applied to the Y-Y axis and measured. The difference between the two readings is the out-of-roundness.

—W. H. Meiklejohn. *Machinery*, Vol. 51, Jan. 1945, pp. 147-151.

Gage Blocks

Condensed from "Modern Machine Shop"

Gage blocks, precision standards of measurement, are used today in quantities undreamed of before the war. Formerly considered largely as inspection equipment, gage blocks have now moved into the shop because of the rigid precision demands of war production. Present high standards have necessitated their use in actual production, in setting of lathes, milling machines, shapers and grinders. Their use improves accuracy, reduces rejections, saves manhours, and cuts down waste.

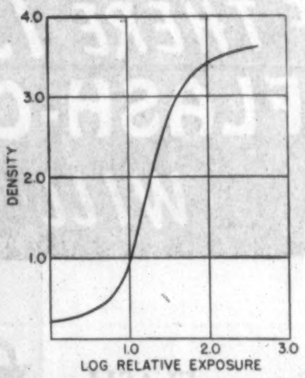


Q. Which x-ray film for shortest possible exposures of thick welds?

A. Kodak's Type F

FOR fast examination of welds in thick material, practical experience calls for Kodak Industrial X-ray Film, Type F, with Special Kodak Industrial X-ray screens. (1) Because it provides the highest available speed for kilovoltages from 100 to 400 . . . and (2) because the contrast of this film-screen combination is the highest obtainable, consistent with high speed.

Kodak's Industrial X-ray Film, Type F, is intended primarily for use with calcium tungstate screens and is first choice when the most important requisite is "shortest possible exposure." Eastman Kodak Company, X-ray Division, Rochester 4, N. Y.



Characteristic Curve, Kodak Industrial X-ray Film, Type F, with double intensifying screens of calcium tungstate.

Development: Five minutes, at 68° F., in Kodalk X-ray Developer or Kodak Liquid X-ray Developer.

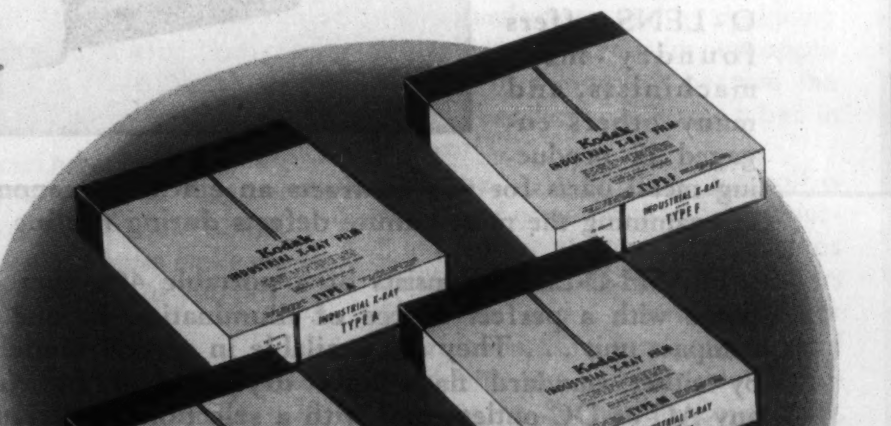
Kodak Provides the 4 Types of Film Needed in Industrial Radiography

In addition to Type F . . .

Kodak Industrial X-ray Film, Type A **. . . most often used for light alloys at lower voltages and for million-volt radiography of thick steel and heavy alloy parts.**

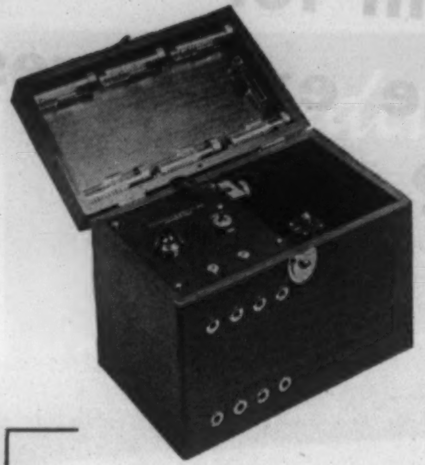
Kodak Industrial X-ray Film, Type K **. . . for gamma and x-ray radiography of heavy steel parts, or of lighter parts at low voltages where high film speed is required.**

Kodak Industrial X-ray Film, Type M **. . . first choice for critical inspection of light alloys and with million-volt radiography of thinner steel and heavy alloy parts.**



. . . the FILM tells the story

Kodak



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HARDNESS TESTING
for quality control

The Eberbach Micro Hardness Tester accurately measures the hardness of the structural constituents of metallic alloys and other materials which cannot be measured by standard methods. The values determined by this highly localized testing are comparable with other hardness tests.

Particle hardness tests with this precise laboratory tool are now widely used to check specifications of single grains in alloys, plated surfaces, nitrided and cyanided layers, and pieces too small for other testers.

The Eberbach tester is equipped with an indenter unit designed to mount on any metallurgical type microscope. A diamond indenter permits measurement directly in units instantly convertible to other systems. Data may be taken visually or photographically.

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Gage blocks, as used in the machine shop, are perishable tools. Even many small shops have from five to ten sets of gage blocks, ranging from the inspection set with its calibration certificate, to the slightly worn work set that has reached the machine shop for use on machine tools.

A set should be available for checking the tools of every milling machine operator, every lathe hand, every grinding machine operator, and every man who runs a jig borer. In grinding a solid gap gage, the size can be determined by checking with a block and re-checking until the proper dimension has been reached.

In grinding a precision keyway in a round bar to a specific size, trial checks can be made with a gage block combination during the process. In setting a milling cutter to the exact center, a set of gage blocks should be considered a shop necessity.

In addition, gage blocks are useful for determining whether a micrometer is accurate in the lead, if a snap gage has worn under the dimension required and to set a vernier caliper or height gage.

—K. F. Kirchhofer. *Mod. Machine Shop*, Vol. 17, Feb. 1945, pp. 168-170, 172, 174, 176, 178, 180.

Using Two-Million-Volt X-Ray

Condensed from "Steel"

A General Electric Co. two-million-volt X-ray unit, weighing 5000 lb., is mobile in the sense that it can be moved by crane and positioned at any angle by push-button control of fractional horsepower motors. Steel castings of the thicknesses for which it would be used might weigh hundreds of tons, and where such masses are handled, a 2½-ton X-ray outfit is relatively light.

The apparatus employs a multiple-electrode tube in which the electrons, starting from a heated filament at the top, are speeded in 24 stages, averaging 83,500 volts at each stage, until they have the total rated energy. After they attain full speed, they strike a copper-backed tungsten target at the end of the tube generating X-rays.

Tubes were constructed by the use of rings of fernico, an alloy that expands with heat as does glass, so metal and glass can be fused together. High voltage is supplied by a resonance transformer that has no iron core, and the X-ray tube is placed at its axis. Tube and transformer are enclosed in a metal tank containing Freon gas for insulation.

X-rays of lower voltage often require a great range between exposure times for metals of different thickness. This is not the case with the two-million-volt machine. Excellent radiographs may be taken through objects made of different materials.

Placing the X-ray tube at a distance from the object increases accuracy of pictures by reducing distortion.

—*Steel*, Vol. 116, Jan. 15, 1945, pp. 95, 120.

Unretouched photograph of the original Machlett Laboratory

The Machlett "White Room", first in the industry

Machlett Laboratories, Springdale

EVEN 43 YEARS AGO Machlett TUBES WERE PRAISED

Machlett Laboratories, Norwalk

Machlett Diffraction Tube with beryllium window. Used in analyzing quartz crystals for war and other radio purposes, and in metallography.

IN 1902 Dr. W. J. Morton, distinguished scientist, doctor and pioneer in the then-new field of roentgenology, wrote to Robert H. Machlett:

> *"My special tube, as you manufactured it, is truly a success and I don't know how I could obtain anything better. Please make me another one as soon as you possibly can."*

Though little was known about X-rays at that time, one thing was clear to the men using them: the best tubes available were made by Machlett. We believe that is still true today.

The transition from the original Machlett Laboratory to the two modern plants at Springdale and Norwalk, Connecticut, was a gradual process. It was made possible by constant improvement in the tubes, by developing new techniques for their manufacture, and by designing and making new types for new applications. Thus Machlett became the largest producer of X-ray tubes in the world.

Today we also apply our half a century of experience to the production of other electron tubes, such as oscillators, amplifiers and rectifiers for radio and industrial uses. For information as to available types of Machlett tubes, write Machlett Laboratories, Inc., Springdale, Connecticut.

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Fabricated Tube Parts. Calumet & Hecla Consolidated Copper Co., Wolverine Tube Div. (3-531)

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Salt Baths. Park Chemical Co. (5-334)

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Electronic Heating. Scientific Electric Div., "S" Corrugated Quenched Gap Co. Complete data on electronic heating, including specifications and illustrations of typical applications, are presented in a 12-page bulletin. (5-605)

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Electric Heaters and Heating Devices. General Electric Co. A complete line of immersion, cartridge, strip and unit heaters, control equipment, etc. is presented in a 56-page, illustrated bulletin, No. GED-650 B. Prices are included. (5-601)

Salt Bath Quenching Processes. Ajax Electric Co., Inc. (5-591)

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Silver Brazing Alloy. Sherman & Co. (7-324)

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Arc Welding. Lincoln Electric Co. The story of arc welding as portrayed in a technicolor sound movie is discussed in a 6-page, illustrated folder. (7-363)

Electrode Chart. Metal & Thermit Corp. Complete data on Murex electrodes for mild, stainless and low-alloy steels, and hard surfaces, are interestingly presented in a colorful wall chart. (7-361)

Hard Facing. Mir-O-Col Alloy Co. A welder's guide to successful hard facing is the subject of an interesting, 32-page, illustrated booklet. (7-359)

Hard-Surfacing Electrodes. Rankin Manufacturing Co. The numerous advantages of Ranite smooth-flowing, hard-surfacing electrodes are listed in a 2-page bulletin. Prices are included. (7-362)

A-C Welders. Allis-Chalmers Mfg. Co. (7-214)

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Gas Welding and Cutting Apparatus. Victor Equipment Co. Comprehensive data on a complete line of gas welding and cutting apparatus are presented in a 104-page, illustrated catalog. Specifications are included. (7-364)

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Resistance Welding Applications. Progressive Welder Co. (7-332)

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Wire Drawing Compound. E. F. Houghton & Co. Houghto-Draw 200-C, a ready-to-use copper wire drawing compound of coarse, intermediate and fine sizes, is described in a 4-page, illustrated bulletin. (8-629)

Stretch-Forming Machine. Hufford Machine Works, Inc. This 2-page bulletin describes and illustrates the Model A-5 hydraulic stretch-forming machine, and lists its attachments, and specifications. (8-636)

Inclinable Open Back Presses. V & O Press Co. An attractive, 24-page bulletin, No. 45, describes and profusely illustrates a complete line of inclinable open back presses for blanking, forming, drawing, etc. Specifications are included. (8-633)

Molding Press. Watson-Stillman Co. A 200-ton hydraulic molding press of the "moving-up" ram type, used for both conventional compression molding and transfer molding, is described and illustrated in a 1-page bulletin. Specifications are included. (8-635)

Pipe and Tube Bending Machines. American Pipe Bending Machine Co., Inc. (8-519)

Hydraulic Presses. Anderson Brothers Mfg. Co. (8-279)

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Power Presses. Clearing Machine Corp. (8-581)

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Standard Marking System. Abrasive Co., Div. Simonds Saw & Steel Co. This 6-page bulletin, No. ESA-72, describes and illustrates this company's standard marking system for grinding wheels and other bonded abrasives. (8-621)

Carbide Tipped Tools, Blanks, Etc. Allegheny Ludlum Steel Corp. This 8-page bulletin discusses Carmet carbide blanks, carbide tipped tools and AL tool shank steel in cold drawn bar form. Specifications are included. (8-623)

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Plate Planers. Baldwin Locomotive Works, Baldwin-Southwark Div. Bulletin No. 190, eight pages, profusely illustrates and describes a variety of heavy- and medium-type plate planers. (8-624)

Coolant and Cutting Oil Strainers. George Butler Co. A new Metex strainer for grinders, lathes, broaching machines, etc. is described and illustrated in a 4-page bulletin. (8-625)

Taps and Tapping Problems. Greenfield Tap & Die Corp. Complete data on the selection and use of the proper taps for individual requirements are presented in a 128-page, illustrated handbook. Specifications are included. (8-627)

Hydraulic Surface Grinders. Hill Acme Co. Precision production obtained with Open-Side hydraulic surface grinders, in both horizontal and vertical spindle design, is discussed in an illustrated, single sheet. (8-628)

Tool Grinders and Fixtures. K. O. Lee Co. This 6-page, pocket-size folder describes and illustrates a variety of Universal tool grinders and fixtures. (8-630)

Coolant Pumps. Logansport Machine Co. A complete line of Sure-Fire centrifugal coolant pumps is described and illustrated in a 28-page bulletin. Helpful engineering data are included. (8-626)

Gear Shaper. Michigan Tool Co. Model 18-43 Shear-Speed gear shaper for rough and semi-finish cutting gears up to 4-in. diam. and 2-in. face width is described and illustrated in a 4-page bulletin, No. 1843-44. (8-631)

Grinding and Finishing Method. Minnesota Mining & Manufacturing Co. High-speed, heavy duty grinding and finishing of metal surfaces with 3-M abrasive belts and the correct segment face contact wheels is described in a 12-page, pocket-size, illustrated folder. (8-632)

Internal Grooving Tool. Waldes Koh-I-Noor, Inc. The Truarc grooving tool for cutting internal grooves in bores or housings is described and illustrated in a 4-page, pocket-size folder. (8-634)

Clamps and Cylinders. Airop, Inc. (8-584)

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Screw Thread System, and Inserts. Aircraft Screw Products Co., Inc. The Aero-Thread screw thread system for high fatigue loads, and Heli-Coil screw thread inserts for use with both coarse and fine threads are described and illustrated in a 4-page bulletin, No. 239. (8-622)

Screws, Bolts, Nuts, Etc. Aluminum Co. of America. (8-442)
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9. Cleaning • Finishing

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Metal Washing Machine. American Foundry Equipment Co. Bulletin No. 19, revised, describes and illustrates the Tabl-Spray metal washing machine for high-speed washing of flat, fragile work or circular parts with intricate pockets and crevices. (9-516)

Cleaning Equipment. Optimus Equipment Co. A complete line of metal washing, cleaning and drying equipment is presented in a 4-page, illustrated bulletin, No. 4El. (9-517)

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Phosphate Coating. Oakite Products, Inc. A 2-page, Special Service Report discusses the Oakite Cryscoat process, an application of phosphate coatings to ferrous rods and wire in wire drawing. (9-520)

Corrosion-Resistant Finish. Rheem Research Products, Inc. This one-page reprint describes Iridite, a corrosion-resistant final finish for zinc and cadmium surfaces. (9-518)

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Radium Paint. Lustrolite Cleveland Corp. Complete data on radium paint and other luminous paint compounds for use on instrument dials, control panels, etc., are presented in a 4-page, illustrated folder. (9-519)

Plastic Coatings. American Pipe & Construction Co. (9-462)
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Storage and Mixing Equipment. U. S. Stoneware Co. Bulletin No. 405, eight pages, describes and illustrates a complete line of tanks, jars, pots and trays for the storage and mixing of acids and corrosive materials. Specifications are included. (9-521)

Corrosion Resistant Ceramics. Atlas Mineral Products Co. (9-72)
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10. Testing • Quality Control

CONTROL INSTRUMENTS

Ratio Control. Askania Regulator Co. (10-586)
Micro Pressure Switches. Barber-Colman Co. (10-418)
Remote Mechanical Control. M. L. Bayard & Co. (10-623)
Air Controllers. Bellows Co. (10-602)
Pyrometer Accessory Manual. Bristol Co. (10-482)
Pyrometers and Salt Baths. Brown Instrument Co. (10-399)
Temperature Control. Burling Instrument Co. (10-620)
Combustion Control. Cities Service Oil Co. (10-518)
Sight Flow Indicators. Fischer & Porter Co. (10-534)
Operation-Time Recorders. Foxboro Co. (10-321)
Photoelectric Relays. General Electric Co. (10-359)
Portable Pyrometer. Illinois Testing Laboratories, Inc. (10-568)
Tachometers. Jones Motrola Co. (10-591)
Electric Control for Salt Pots. Leeds & Northrup Co. (10-597)
Precision Instruments. P. R. Mallory & Co., Inc. (10-500)
Electric Timers. Paragon Electric Co. (10-605)
Thermocouples, Etc. Revere Co. (10-583)
Thermocouples, Etc. Wheelco Instruments Co. (10-609)

HARDNESS TESTING

Hardness Tester. Wilson Mechanical Instrument Co., Inc. This 2-page bulletin, No. MP-4, describes and illustrates the Rockwell hardness tester for precision testing. (10-632)

Ferrous and Non-Ferrous Hardness Tester. Clark Instrument, Inc. (10-236)

INSPECTION DEVICES

Optical Contour Comparator. Fish-Schurman Corp. Precision performance in contour comparison, strain finding, projection, etc., attained through the use of an optical contour comparator, is described in a 4-page, illustrated bulletin, No. OC-305. (10-628)

Precision Gages. Standard Gage Co., Inc. A complete line of standard precision gages, available in a wide range of types and sizes, is presented in a 16-page, illustrated bulletin. Specifications and prices are included. (10-631)

Dial Indicators. B. C. Ames Co. (10-522)

Thread Plug Gages. Cadillac Gage Co. (10-608)

Illuminated Magnifiers. R. P. Cargille. (10-603)

Quality Control with Gages. Continental Machines, Inc. (10-618)

Identification of Steel. Dravo Corp. (10-271)

Electronic Metal Identifier. Allen B. Du-Mont Laboratories, Inc. (10-529)

Magnaflux. Magnaflux Corp. (10-288)

Dynamics Measurement Equipment. Glenn L. Martin Co. (10-601)

Measuring Surface Roughness. Physicists Research Co. (10-582)

Illuminated Magnifiers. E. W. Pike & Co. (10-345)

Micrometers. George Scherr Co., Inc. (10-472)

Abrasive Wear Tests. Taber Instrument Co. (10-233)

Testing Methods. Triplett & Barton, Inc. (10-615)

MECHANICAL TESTING

Strain Gage. Baldwin-Southwark Div. (10-314)

Electronic High-Magnification Recorder. Tinius Olsen Testing Machine Co. (10-344)

Universal Testing Machines. Riehle Testing Machine Div., Am. Machine & Metals, Inc. (10-386)

METALLOGRAPHIC EQUIPMENT

Metallurgical Testing Apparatus. Buehler, Ltd. (10-80)

RADIOGRAPHY

X-Ray and Radium Protection. Bar-Ray Products, Inc. Technical data on X-ray and radium protection, including recommendations of the U. S. Bureau of Standards, are presented in a new bulletin. (10-626)

X-Ray Diffraction. North American Philips Co., Inc. This 4-page reprint describes and illustrates the technique employed in Norelco film-type X-ray equipment for identification of materials. (10-630)

Films for Industrial Radiography. Ansco. (10-278)

X-Ray Film. Eastman Kodak Co. (10-170)

The X-Ray in Industry. General Electric X-Ray Corp. (10-10)

Film Dryer. Pako Corp. (10-588)

X-Ray Equipment. Picker X-Ray Corp. (10-477)

SPECTROGRAPHY

Universal Spectrophotometers. Wilkens-Anderson Co. (10-180)

LABORATORY AIDS

Buffer Tablets. Burrell Technical Supply Co. Coleman certified buffer tablets, for instrument standardization without further dilution, and Coleman concentrated buffer tablets for operation in the field or factory, are discussed in a 4-page, illustrated bulletin, No. B-205. (10-627)

Testing and Laboratory Equipment. Gamma Instrument Co., Inc. A variety of instruments and apparatus for testing and laboratory work is described and illustrated in a 4-page bulletin. Prices are included. (10-629)

Optical Glass. Bausch & Lomb Optical Co. (10-291)

Laboratory Equipment. Central Scientific Co. (10-507)

Metallurgical Laboratory Equipment. Precision Scientific Co. (10-625)

High-Speed Electrolytic Analysis. E. H. Sargent & Co. (10-219)

11. Equipment and Machinery, General

Colloidal Graphite Dispersions. Acheson Colloids Corp. A complete line of Dag colloidal and semi-colloidal dispersions, available in a choice of carriers, such as distilled water, glycerine, petroleum oil, etc., is presented in a 4-page bulletin, No. 440. (11-330)

Adjustable Triangle. Charles Bruning Co., Inc. A convenient, adjustable triangle, made of heavy, highly transparent plastic with molded-in calibrations of half degrees, ideal for drawing screw threads, helical springs, etc., is described and illustrated in a 6-page, pocket-size folder. (11-324)

Conveyors. Chain Belt Co. A variety of Rex apron and pan feeders and conveyors for handling coal, ore, cement, rock, bulk parts, etc., are described and illustrated in a 6-page folder, No. 462. Specifications are included. (11-325)

Dust Collector. Ideal Commutator Dresser Co. This 2-page bulletin describes and illustrates a dust collector that is inexpensive, powerful, and has twin-cyclone cleaners. Specifications and prices are included. (11-331)

Autoclaves. Industrial Machinery Co. Bulletin No. 50, two pages, describes and illustrates the Alberger one-gallon autoclave, which may be used as a high pressure impregnator of magnesium, powdered metal parts, etc. (11-332)

Vibration Control. Korfund Co., Inc. Efficient vibration control for punch presses, hammers, grinders, etc. with the Type SL Vibro Isolator, loading range 200 to 12,000 lb., is discussed in a 4-page bulletin, No. SL-500. (11-327)

Air Control. Manning, Maxwell & Moore, Inc. This 4-page bulletin describes and illustrates a new Ashcroft air control for shallow well pumps—applications up to 80 lb. p.s.i. tank pressure. (11-326)

Centrifugal Pumps. Marlow Pumps. Interesting and valuable data on self-priming centrifugal pumps are presented in a 20-page, illustrated bulletin. (11-333)

Steam Condenser. Niagara Blower Co. A diagram of operation of the Aero steam condenser is presented in bulletin No. 99, one page. (11-328)

Please Use the Coupon on Page 1119

Sludge Pumps. Claude B. Schneible Co. Bulletin No. 1244, four pages, describes and illustrates Wearproof sludge pumps, available in both horizontal and vertical types. Specifications are included. (11-334)

Air Handling Equipment. B. F. Sturtevant Co. Engineering data and a complete line of air handling equipment and its applications are presented in an illustrated, 199-page, pocket-size catalog. *Please use company letterhead when requesting this bulletin.* (11-329)

Fluid Handling Equipment. J. A. Zurn Mfg. Co. A complete line of fluid handling equipment for industrial, power plant and process industries installations is presented in a 12-page, illustrated bulletin, No. 45. (11-335)

Air Filtration. American Air Filter Co., Inc. (11-62)

Pulverized Coal. Amsler-Morton Co., Inc. (11-162)

Dry Chemical Fire Extinguishers. Ansul Chemical Co. (11-310)

Production Research. Battelle Memorial Institute. (11-296)

Acid-Proof Brick Floors. Belden Brick Co. (11-314)

Centrifugal Pumps. Bell & Gossett Co. (11-304)

Fans and Air Conditioning Equipment. Chelsea Fan & Blower Co., Inc. (11-295)

Mounted Wheels for Portable Tools. Chicago Wheel & Mfg. Co. (11-70)

Protective-Type Motor. Crocker-Wheeler Div., Joshua Hendy Iron Works. (11-320)

Filters. Cuno Engineering Corp. (11-121)

Magnets and Magnetic Separators. Dings Magnetic Separator Co. (11-232)

Pumps and Gages. Distillation Products, Inc. (11-309)

Flexible Shafting for Packaging. Dow Chemical Co. (11-183)

Induction Generators. Electric Indicator Co. (11-301)

Central Pumping Unit. Farval Corp. (11-323)

Refrigeration and Air Conditioning Equipment. General Electric Co. (11-243)

Leather Belting. Graton & Knight Co. (11-308)

Fluid Cooler. Gray-Mills Co. (11-211)

Hydraulic Equipment. Hydraulic Machinery, Inc. (11-201)

Fans, Blowers, Etc. Ilg Electric Ventilating Co. (11-303)

Compressors and Vacuum Pumps. Ingersoll-Rand Co. (11-221)

Impregnating Castings. Jackson & Church Co. (11-222)

Trucks, Cranes, Etc. Lewis-Shepard Co. (11-312)

Hydraulic Equipment. Lyon-Raymond Corp. (11-299)

Dust Preventives. Parsons Engineering Corp. (11-233)

Oil Burners. Peabody Engineering Corp. (11-311)

Water Softening. Permutit Co. (11-42)

Banding and Splicing Method. Punch-Lok Co. (11-307)

Technical Books. Reinhold Publishing Corp. (11-273)

Centrifugal Blowers. Roots-Connersville Blower Corp. (11-102)

Lubrications for Steam Turbines. Sinclair Refining Co., Inc. (11-197)

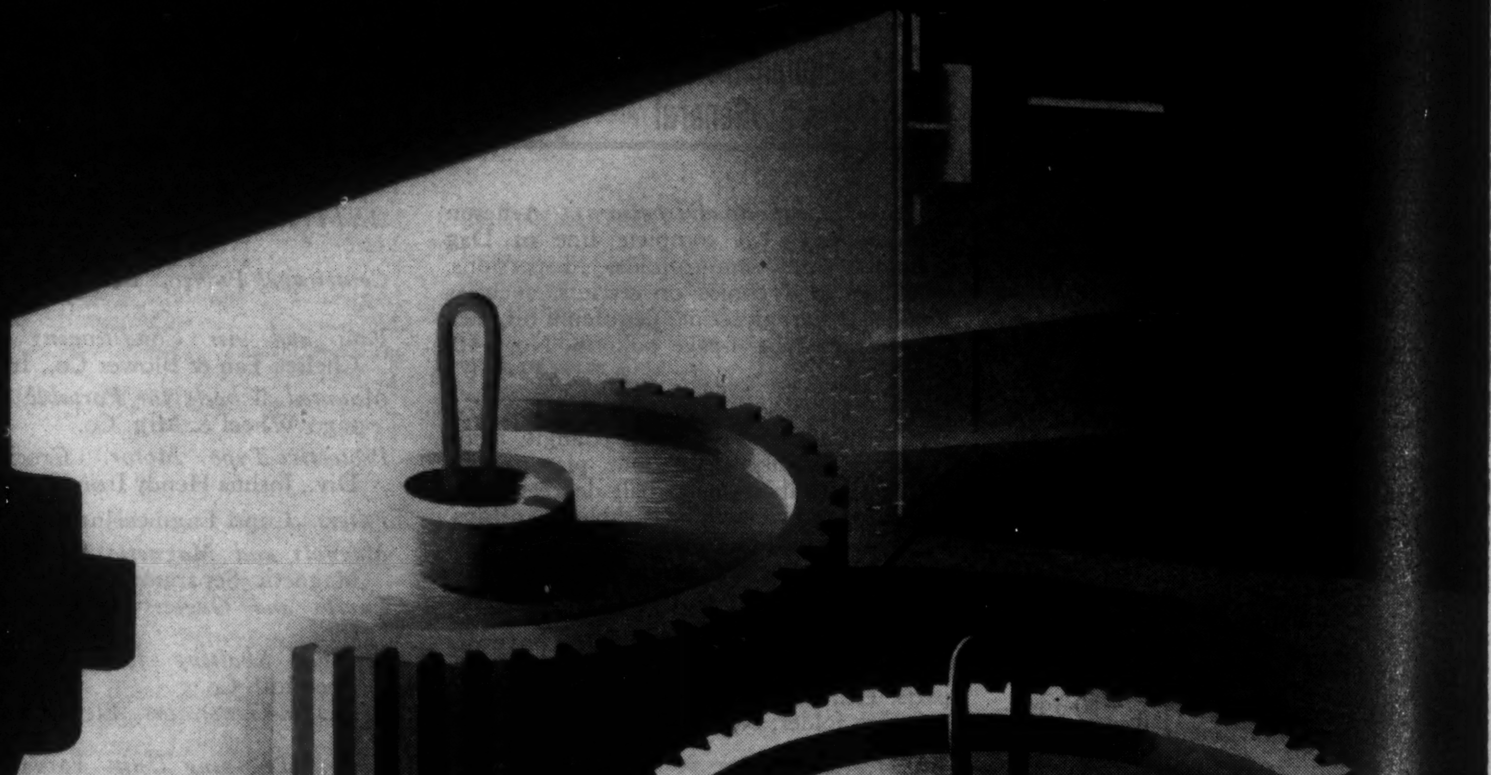
Dual Progressive System of Lubrication. Stewart-Warner Corp. (11-262)

Fans. Trane Co. (11-54)

Cooling and Conditioning Equipment. Westinghouse Electric Elevator Co., Air Conditioning Div. (11-213)

Oil Purifiers. Youngstown Miller Co. (11-165)

Molybdenum steels require relatively high tempering temperatures and therefore are relatively free from internal stresses.



CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

ARMY E NAVY

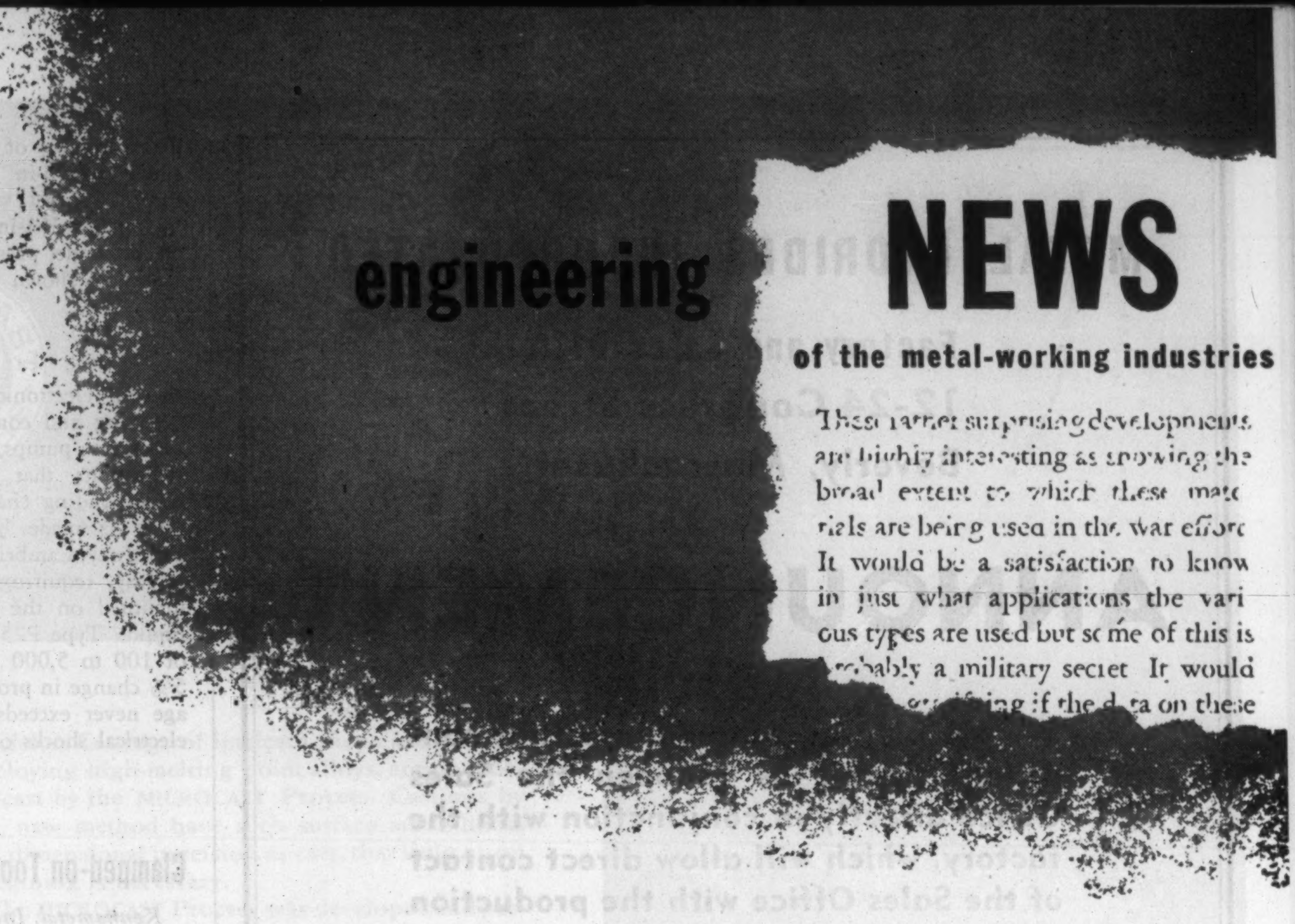
MOLYBDIC OXIDE, BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

MOLY

Climax Molybdenum Company
500 Fifth Avenue • New York City

engineering NEWS

of the metal-working industries

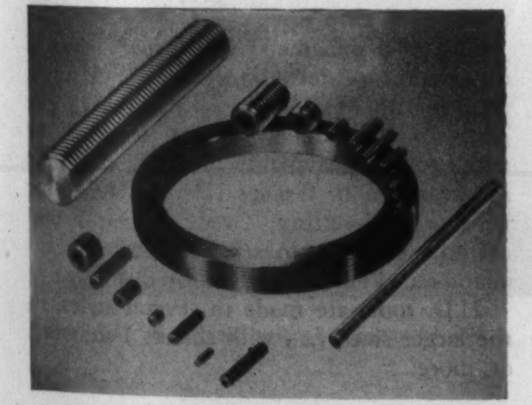


These rather surprising developments are highly interesting as showing the broad extent to which these mate rials are being used in the war effort. It would be a satisfaction to know in just what applications the vari ous types are used but some of this is probably a military secret. It would gratifying if the data on these

Centerless Thread Grinder

Developed to fill the need for a method of producing screw threads that would be highly accurate and provide a smooth surface, *Landis Tool Co.,* Waynesboro, Pa., has announced a centerless thread grinder. Although the centerless grinding of threads is new, the machine has been on experimental run long enough to confirm the principles upon which it is designed, and the production rates obtainable with it.

The machine is the result of more than a year's intensive development and research headed by Maurice Gjesdahl, research engineer for Landis Tool Co. It is based upon the idea that a blank, entering the throat between the grinding wheel and the regulating wheel, would index itself in the grooves of the grinding wheel, in the same manner as a thread die indexes itself. The grinding wheel, like the thread die, is formed so that the blank can enter the throat, and the full thread depth is attained at the opposite side of the wheel.



With the grinding wheel to the right of the screw and its axis horizontal, the top of the work rest must slope downward toward the left of the machine at the helix angle of the thread being ground. The regulating wheel, which has no grooves on its face, is tilted downward at the helix angle with respect to the top of the work, so that its axis is at an angle from the grinding wheel axis twice the helix angle. In this way the grinding wheel, having on its surface a succession of parallel ridges corresponding to the thread form, grinds a spiral groove, or thread, on the work.

The grinding wheel is formed by crushing, the crushing roll having a series of parallel grooves corresponding to the form on the grinding wheel. A setup is provided in which the crushing roll, rather than the grinding wheel, is driven, and this provides another advantage. When one of the crushing rolls shows signs of wear, it may be placed on the machine immediately after dressing the wheel with a perfect roll, and reground to renew its form. Crushing of the grinding wheel is facilitated by building in a crusher attachment, with a motor drive for this unit.

The regulating wheel and its base are mounted to permit universal movement. The throat may be increased or decreased by movement of this part. Adjustments of the grinding wheel base to change the throat may be as small as 0.0001 in., and can be made with a handwheel. The regulating wheel base and the work rest may be tilted to provide the feeding action for the work, angular adjustments being made to the nearest minute of arc.

Proper speed controls are provided to meet all requirements of operation while keeping the number to a minimum.

Experience gained has shown that about one minute of crushing removes about 0.001 in. from the radius of the grinding wheel. Total time required for recrushing a wheel is about 10 to 12 min.

Operation of the Centerless Thread Grinder on commercial hardened stock for sizes varying from No. 4-40 pitch (less than ⅛ in.) to ⅝ in.—11 pitch has shown its production possibilities. An economical grinding rate on ¼ in.—20 screws has been set at about 30 to 35 in. per min. At this rate the wheel may operate as long as 8 hr. continuously without requiring recrushing.

Accuracy in the lead of the thread is 0.0005 in. or less. By reducing speed the error has been reduced to 0.0001 in. Sides of the threads are smooth and straight. The roots of the threads tend to a slightly rounded form, and this might be expected to reduce the notch effect in the screws. Class 3 fits are produced in regular runs.

The accompanying photo presents examples of threads ground successfully from hardened steel: Twelve inch long, ¼-in.

(Continued on page 1126)

METAL HYDRIDES INCORPORATED

Factory and Sales Office
12-24 Congress Street
Beverly, Massachusetts

ANNOUNCEMENT

We are pleased to announce that conditions permit us to open the Sales Office directly in conjunction with the factory, which will allow direct contact of the Sales Office with the production and research engineers.

All correspondence on technical and sales matters should be addressed now to the above address.

HYDRIMET PRODUCTS

Titanium Hydride
Zirconium Hydride
Titanium Metal
Zirconium Metal
Thorium Metal
Metal Nitrides
Copper-Titanium
Copper-Zirconium
Beryllium-Nickel
Titanium-Nickel
Cobalt Alloys
Special Products
***Calcium Hydride**

*A foolproof, convenient, easily transported source of hydrogen.

diam. screws of 20 pitch ground on a single pass; 5-in. diam. rings with 16 pitch threads; socket screws from ⅛-in. diam., 40 pitch to ⅝-in. diam., 11 pitch ground on a single pass. Blanks for the socket screw are shown in the foreground.

● An electronic concentrate control for detecting and controlling, through signals, valves or pumps, changes in liquid concentrations that are accompanied by a corresponding change in electrical conductivity is made by *Photoswitch, Inc.*, 77 Broadway, Cambridge 42, Mass. Installation is easy, requiring that a probe fitting be mounted on the tank, with probe in the liquid. Type P25N has a sensitivity range of 100 to 5,000 ohms, and operates on a 5% change in probe-circuit resistance. Voltage never exceeds 25 v., thus eliminating electrical shocks or explosions.

Clamped-on Tools for Heavy Machining

Kennametal, Inc., of Latrobe, Pa., is now producing a line of "H.D." tools having clamped-in and advanceable Kennametal tips, for heavy-duty machining on steel castings, forgings and bar stock, and cast iron. The H.D. design has been made possible by the development of heavy-duty Kennametal tips, which, while overhanging the tool shank by about 1/16 in., have ample strength to take heavy feeds and depths of cut.

The special type of Kennametal tip used in the H.D. tool has a clamping shelf along the top of the side opposite to the cutting edge. It is diamond ground on the under side. When dull, the tip is advanced, and resharpened. The tip may be reground many times, since it is advanced to the front and side, in the oblique recess, until the major part of it has been utilized. Only the cutting edge is ground, and no steel is removed in the process.

The recess in the hardened steel shank is finished plane and true with a Kennametal-tipped fly cutter, or a Kennametal end file. The clamp and set screw, positioned to avoid abrading, permit smooth, unimpeded chip flow.

Use of Kennametal H.D. tools permits minimum tool stocks, since one shank serves for the life of many tips, and the proper grade of Kennametal tip can be used for each job. Heavy-duty Kennametal tips are available in Grades KM and K3H for general steel-cutting, Grade K2S for machining steel castings where scale is encountered, and Grade K6 for cast irons.

H.D. tools are made in several styles, in the larger sizes, *i.e.*, with shanks 1-in. wide, or more.

● What is claimed to be the longest molded plastice product ever manufactured is a 17-ft. radar housing for the *Douglas Aircraft Co.* Low-pressure molded, it consists of a glass-fabric filter. It is announced by *General Electric Co.*, 1285 Boston Ave., Bridgeport 2.

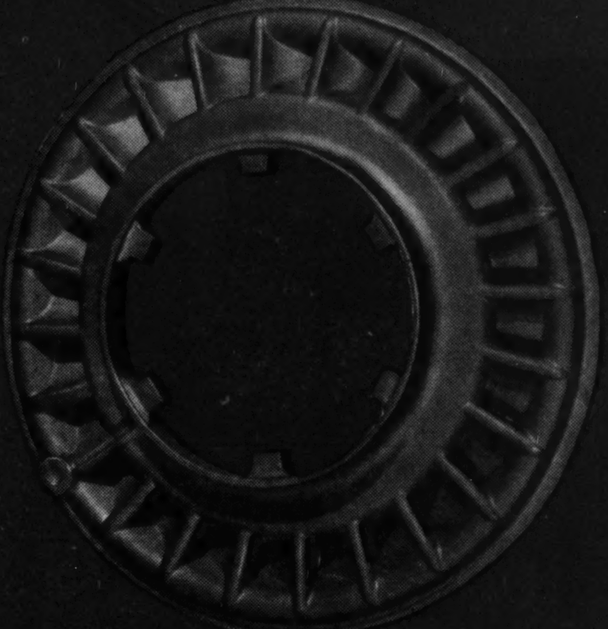
MICROCAST
PRECISION
CASTINGS
PROCESS

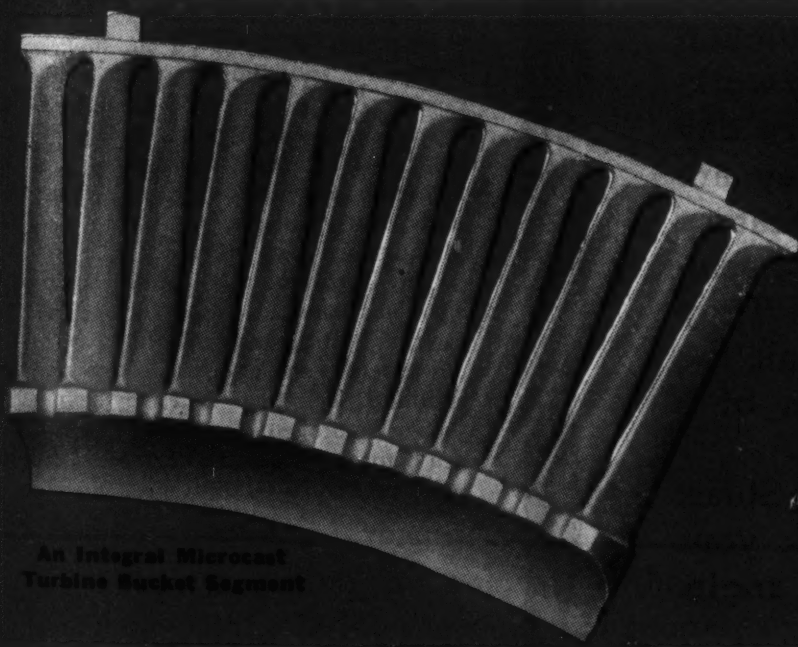
A High Precision Casting Process Requiring Little or No Machining

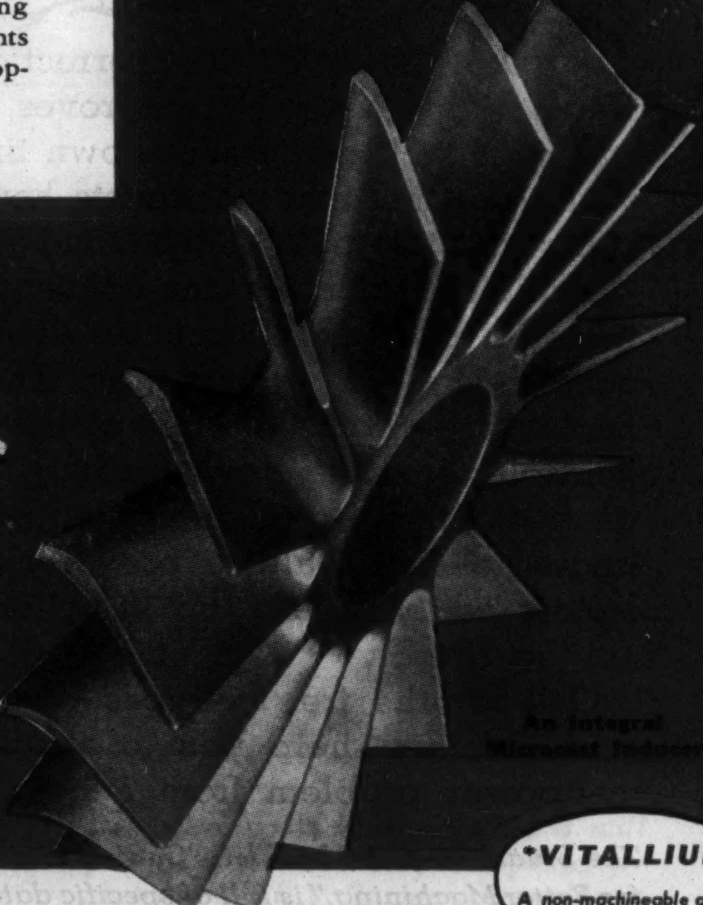
Precision Castings of intricate shape and design, employing high-melting point alloys, are now being cast by the MICROCAST Process. Castings by this new method have such surface smoothness and dimensional precision as cast, that little or no machining is necessary.

The MICROCAST Process was developed and perfected sixteen years ago by Austenal Laboratories, Inc. for the casting of dental and surgical appliances of Vitallium,* a Cobalt-Chromium, Molybdenum Alloy with a melting point of approximately 2500 degrees F.

The success of the MICROCAST Process in the quantity production of parts from high-fusing alloys has created keen industrial interest. It points the way to even wider usage in postwar development work.


An Integral Microcast Nozzle Diaphragm


An Integral Microcast Turbine Bucket Segment


An Integral Microcast Inducer

***VITALLIUM**
A non-machineable alloy

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MICROCAST

The precision process originated by Austenal Laboratories, Inc. for the production of castings of intricate design where accurate dimensions and surface smoothness are absolutely essential. Small castings produced by the Microcast Process require little or no machining. Consider Microcast in your postwar plans.

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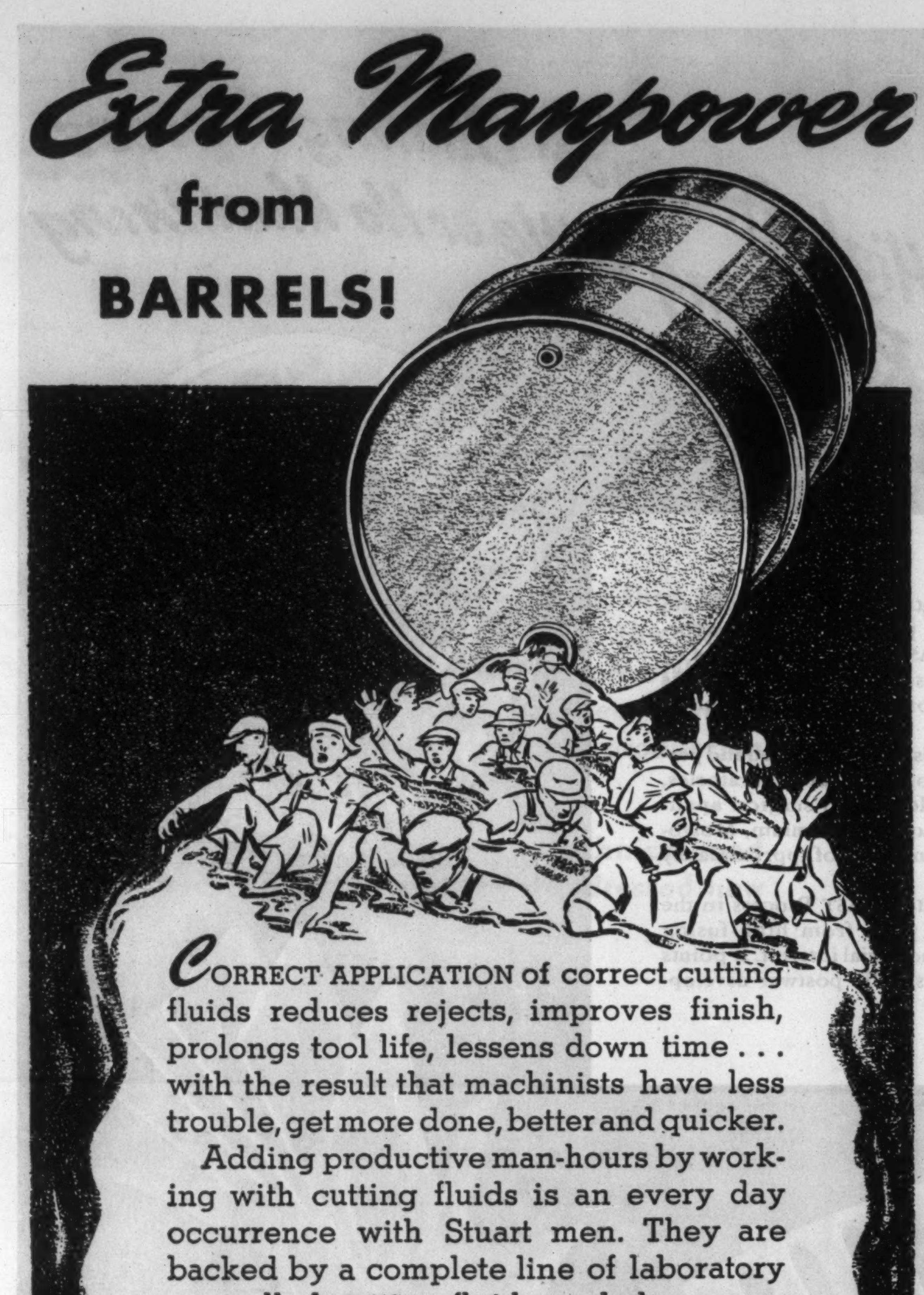

Extra Manpower from BARRELS!

CORRECT APPLICATION of correct cutting fluids reduces rejects, improves finish, prolongs tool life, lessens down time . . . with the result that machinists have less trouble, get more done, better and quicker.

Adding productive man-hours by working with cutting fluids is an every day occurrence with Stuart men. They are backed by a complete line of laboratory controlled cutting fluids made by a company of eighty years experience. They know how to evaluate properly all the factors which affect the selection of a cutting fluid.

Call for the free services of a Stuart man. Let him help you to attack your manpower problem from a new angle.

The Stuart 60-page booklet, "Cutting Fluids for Better Machining," is full of specific data, well illustrated. Write for your free copy.

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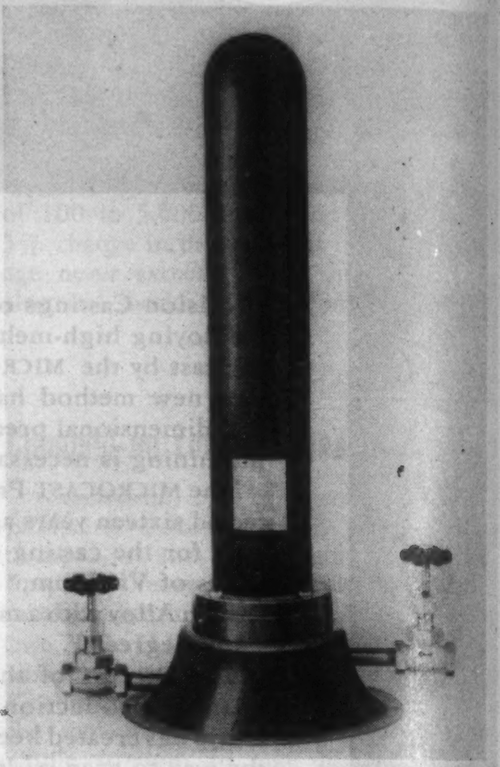
2745 SOUTH TROY STREET, CHICAGO 23, ILL.
ESTABLISHED 1865
Warehouses in Principal Metal-Working Centers

Gas Purifier

A newly developed gas purifier that uses palladium as a catalyst at room temperature, called the "Deoxo," is introduced by *Baker & Co., Inc.*, Newark, N. J. It removes oxygen from such gases as hydrogen, nitrogen, argon and neon. Gas with less than 20 parts of impurity in a million are thus obtainable.

It is important in heat treatment of alloys, powder metallurgy, the manufacture of radio and radar tubes, and for all research laboratories using pure gases. The unit is produced in two sizes. The catalyst is encased in metal cylinders provided with intake and outlet valves through which the gas is passed.



One size, standing 20 in. high, is for laboratory and limited production, with capacity of 200 cu. ft. of gas per hr. The other is for general plant operation, measuring 40 in. high, constructed for wall mounting and with 1,000 cu. ft. capacity. Both units will handle up to 50 p.s.i. Maintenance costs are nil.

The Deoxo unit is claimed superior to apparatus heretofore available. It needs no external heating, nor warming up or cooling down before and after use. Flow resistance is almost negligible. A test by a university showed hydrogen containing 0.1% of oxygen before treatment. After treatment it had been reduced to 0.00001%.

● "Plytube," described as "a new material of countless uses," is announced by *Plymold Corp.*, Lawrence, Mass. A plywood-plastics composite, it may be joined with ordinary glues or synthetic resins. It can be machined with standard woodworking equipment, and can be threaded. It is described as a method of combining alternating spirally wound veneers and longitudinal plys, resulting in unusually high strength. Typical application is a portable, telescopic, extra light antenna mast. Heights up to 90 ft. are available.

Properly
Engineered
Materials
PLUS
Skilled
Application
"Know-how"

TYGON
the chemically inert plastic
RUBBER
GRS or Neoprene
RESILON
hydrocarbon resin
ACID-BRICK and CEMENTS
Vitric-10 — Durisite
LEAD
sheet or homogeneous bonded

THAT, in a nutshell, is the reason why more and more engineers are specifying "tanks to be lined by U. S. Stoneware."

They know that from the wide range of lining materials manufactured by U. S. Stoneware that we can suggest, without prejudice, the lining material best suited for a given job. They know that the skill and knowledge acquired through 80 years of leadership in fabricating corrosion-resistant materials and equipment is assurance of an application technique, an engineering "know-how" that means a better tank lining job no matter what material is used.

On your next tank installation it will pay you to submit your plans or sketches to U. S. Stoneware engineers for their suggestions. No obligation, of course.

U. S. STONEWARE
AKRON, OHIO

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CLEANS METALS FASTER
... ECONOMICALLY

SOLVMAX C is a new, faster acting water emulsifying solvent for spray washing that has been individually formulated by MAC DERMID INC. for positive results.

SOLVMAX C...
Is non-corrosive to any metal.
Quickly removes magna-flux, carbon smut, graphite and other contaminations.
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Can be used hot or cold.

Learn about this new, improved water emulsifying solvent now. Write for free Data Sheets and folders on the many other individually formulated MAC DERMID INCORPORATED compounds for cleaning all metals.

Compounds and Equipment for Metal Cleaning

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WRITE ONE OF THESE SERVICE ORGANIZATIONS FOR FREE DEMONSTRATION

NEW YORK, Udylite Corp (L. I. City)
DETROIT Udylite Corp. Wagner Bros.
CHICAGO Udylite Corp. Geo. A. Stutz Mfg. Co.
CLEVELAND Udylite Corp. McGean Chem Co.
ST LOUIS LaSalco, Incorporated
TORONTO—CAN. Clark Industrial Supplies Co.

Converter for Induction Heating

A new mercury arc converter that fills out the low frequency range of electronic equipment in induction heating applications has been brought out by *Allis-Chalmers Mfg. Co.,* Milwaukee. It changes power at commercial frequencies of 60 or 25 cycles into 1000 to 2000 cycle power, and is good for forging, melting and metal treating applications where large masses of metal or parts must be efficiently heated at kilowatt capacities of 250, 500, 1000 and higher.

Two successful applications have been made in recent months—one a 300 kw. unit in a forge plant; another a 250 kw. unit in the melting section of a brass foundry. They have performed at higher full load and much higher partial load efficiencies than possible with other types of converters for like frequencies, with all costs much lower.

They are quiet and need no ventilation or air filtering, being water-cooled. They give no vibration problems.

● A new compact power tube for high-frequency heating equipment is sponsored by *Federal Telephone & Radio Corp.,* 32 Central Ave., Newark 1, N. J. Designated as F-5303, it is supplied with 6-in. flexible copper leads secured to the tube terminals, eliminating usual damage from adjusting terminal clamps on the tube itself. Featured are sturdy, conservatively spaced filament and grid elements and absence of ceramic insulation, making for shock resistance. Rated at 3500 watts, it operates up to 50 megacycles. It is designed for forced-air cooling, but a water-cooled model is available.

"Un-Freezer" for Salt Baths

Freeze-ups of electric salt bath furnaces no longer require extensive time and trouble in starting up when a new electric salt bath furnace coil introduced by *Upton Electric Furnace Div.,* 7450 Melville at Green, Detroit 17, to "un-freeze" Upton salt baths, is used.

The new starting coil consists of a nichrome heating coil element connected to the output leads of the furnace transformer by two mild steel bars and flexible buses, and operates with the transformer. The time required to place the coil in operation is negligible.

It can be used either before or after the salt in the furnace freezes up. When the furnace is to be shut down, the coil is dropped into the salt bath so that it reaches the bottom of the pot. The power can then be cut and the furnace allowed to freeze up. The leads are connected to the transformer and the power turned on when it is desired to start the furnace again.

With both the starting coil and the normal heat from the electrodes themselves, the salt is melted down in a short time, and the starting coil removed and the furnace ready for use.

(Continued on page 1132)

Solutions to

SOME OF YOUR PROBLEMS

Dag dispersions of colloidal graphite crown with success many a search for solutions to difficult problems like these:

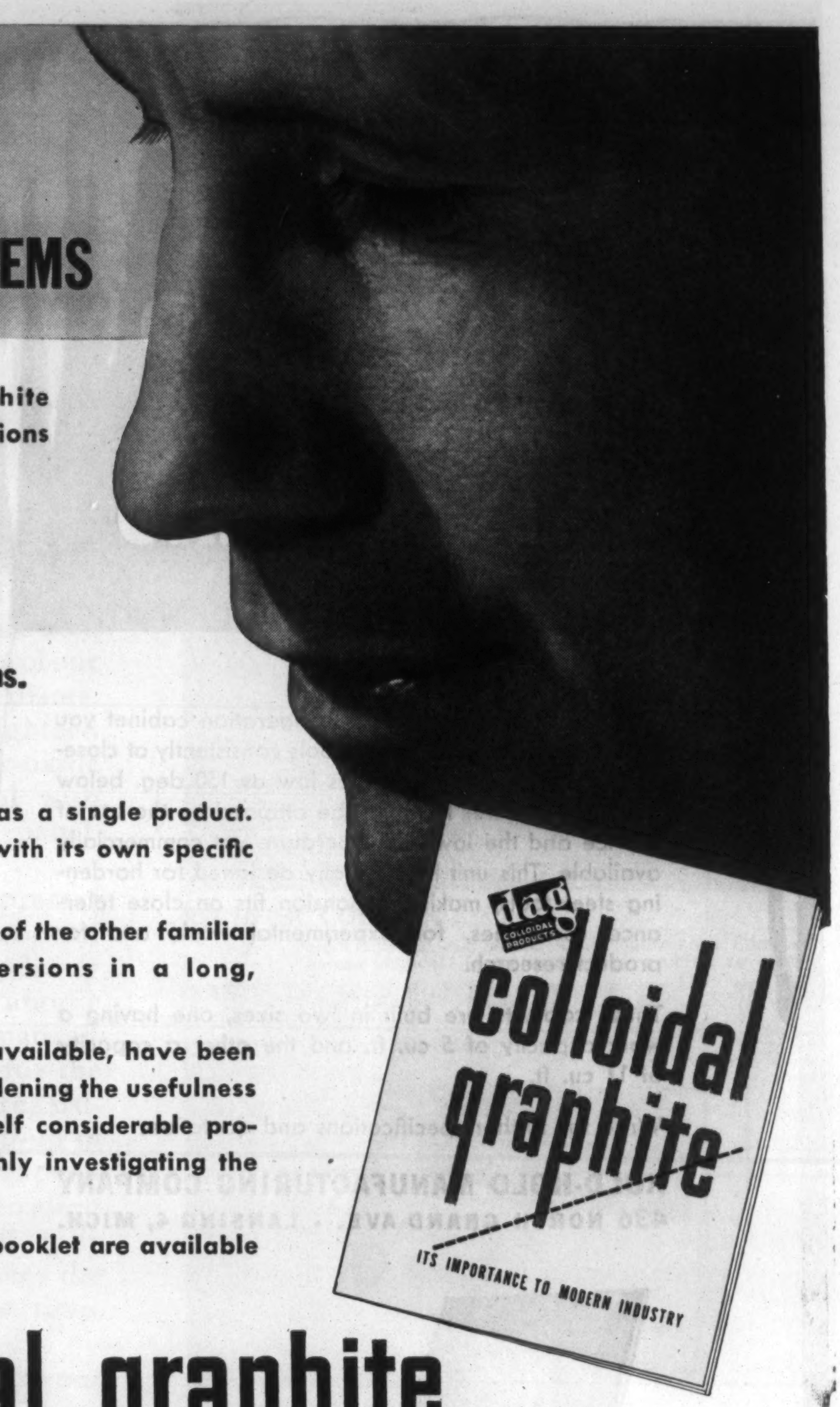
- **Improved Finish on Castings.**
- **Cutting Tool Life.**
- **Lubricating Drawing and Swaging Operations.**
- **Metal Pick-Up on Forging Dies.**

Don't think of **dag** colloidal graphite as a single product. Actually it is many products in one, each with its own specific advantages and applications.

Oildag*, Aquadag, Glydag, and some of the other familiar Acheson products are only a few dispersions in a long, versatile list.

Many **dag** suspensions, hitherto not available, have been developed during the war, thus greatly broadening the usefulness of colloidal graphite. You may save yourself considerable production and maintenance grief by thoroughly investigating the family of **dag** dispersions.

A complete product list and general booklet are available on request without obligation.



dag REG. U.S. PAT. OFF. **colloidal graphite**

ACHESON COLLOIDS CORPORATION, Port Huron, Michigan

A-D1

** Oildag, Aquadag and Glydag are registered trade marks of Acheson Colloids Corporation.*

TO GET THESE

These new bulletins on *specific* applications for **dag** colloidal graphite are yours for the asking

421	**dag** colloidal graphite for ASSEMBLING AND RUNNING-IN ENGINES AND MACHINERY
422	**dag** colloidal graphite as a PARTING COMPOUND
423	**dag** colloidal graphite as a HIGH TEMPERATURE LUBRICANT
431	**dag** colloidal graphite for IMPREGNATION AND SURFACE COATINGS
432	**dag** colloidal graphite in the FIELD OF ELECTRONICS

—just fill in and clip the convenient coupon opposite

MAIL THIS

ACHESON COLLOIDS CORPORATION
PORT HURON, MICHIGAN DEPT. 9-D

Please send me, without obligation, your general booklet on **dag** colloidal graphite, and also free copies of the specific bulletins checked below:

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No. 423 ☐ FIRM __________
No. 431 ☐ ADDRESS__________
No. 432 ☐ CITY_____ZONE No._____STATE_____
OUR PRESENT OIL SUPPLIER IS__________

(Lubricants containing **dag** colloidal graphite are available from major oil companies.)

150°

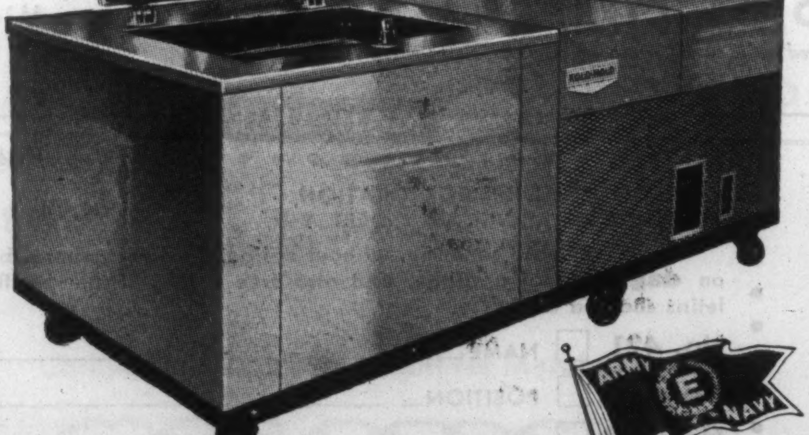
BELOW ZERO

In a KOLD-HOLD electrical refrigeration cabinet you can process metal parts and tools consistently at closely controlled temperatures as low as 150 deg. below zero—much lower than can be attained by the use of dry ice and the lowest temperature yet commercially available. This unit is especially designed for hardening steel tools, making expansion fits on close tolerance assemblies, for experimental work, and for product research.

These cabinets are built in two sizes, one having a work capacity of 5 cu. ft. and the other a capacity of 11 cu. ft.

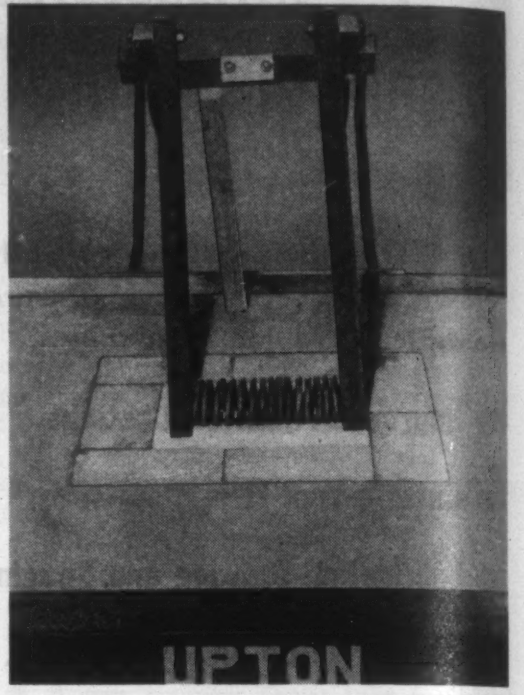
Write for further specifications and quotation.

KOLD-HOLD MANUFACTURING COMPANY
436 NORTH GRAND AVE. • LANSING 4, MICH.



KOLD-HOLD

When the salt has been allowed to freeze up solid without the starting coil in the bath, the salt at the top of the pot is chipped away to provide a nest for the coil and the starting coil placed in the nest as



illustrated. Loose salt is poured into the depression and around the coils until the latter are about half covered. The leads of the starting coil are connected with the transformer and the power turned on.

Melting of the salt from this point on is entirely automatic, requiring no further attention. As the salt at the top melts, the coil gradually works downward, melting the frozen salt as it descends until all the salt in the pot is completely molten.

- A process of automatic carbon arc welding is claimed to be the only method by which aluminum parts for military bridges can be fabricated on a mass scale. It is called by its designer and producer, the *Lincoln Electric Co.,* Cleveland 1, the "electronic tornado." It is a process of shielded carbon arc welding.

All-Purpose Brazing Furnace

A new all-purpose furnace designed for silver brazing at low temperatures, copper brazing at high temperatures, powder metallurgy, bright annealing, general tool hardening and high-speed tool hardening, is sponsored by *Lindberg Engineering Co.,* 2444 W. Hubbard St., Chicago 12. It has a temperature range of 1300 to 2500 F.

It can handle heavy loads at high temperatures, and is well adapted for sintering powdered metals where pieces weigh several hundred pounds. Loading and unloading platforms are arranged for easy handling in and out the furnace. Globar-type heating elements are easily replaced.

Hydryzing, precombusted gas and dry hydrogen atmospheres may be used for bright and clean work. A flame curtain at charge and discharge doors prevents infiltration of air, the curtain igniting automatically when doors are opened. A cooling chamber is filled with proper atmosphere to prevent oxidation during cooling.

ANOTHER

G-E Fully Automatic Anodizing Power Unit Installed

This large automatically controlled power unit for 5000-ampere 40-volt chromic acid anodizing was recently installed in one of our largest B-29 bomber manufacturing plants. Essentially, the unit consists of eighteen G-E "2000" large capacity copper-oxide rectifiers, a motor operated control with its accessories and an operator's panel.

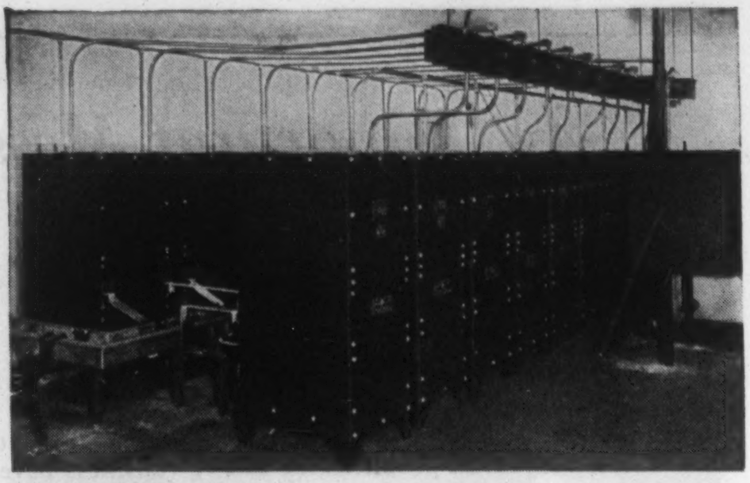
To anodize, the plater simply presses the start button on the operator's control panel. Thereafter the whole anodizing process is fully automatic. When the anodic film is formed the unit shuts off automatically and returns to starting position for the next load. No adjustment is required regardless of the size of load. Voltage build-up in relation to the formation of the film is positively controlled. All chance of overloading the equipment is eliminated. G-E fully automatic power equipment completes the anodizing in the shortest possible time.

For modern anodizing needs, select your power equipment from the G-E line. There are many different rated units from which to choose. Detailed data on request from Section A455-112, Appliance and Merchandise Dept., General Electric Company, Bridgeport, Conn. Write today.

Hear the General Electric radio programs: "The G-E All Girl Orchestra" Sunday 10 P.M. EWT, NBC. "The World Today" news Monday through Friday 6:45 P.M. EWT, CBS. "The G-E House-party" Monday through Friday 4:00 P.M. EWT, CBS.

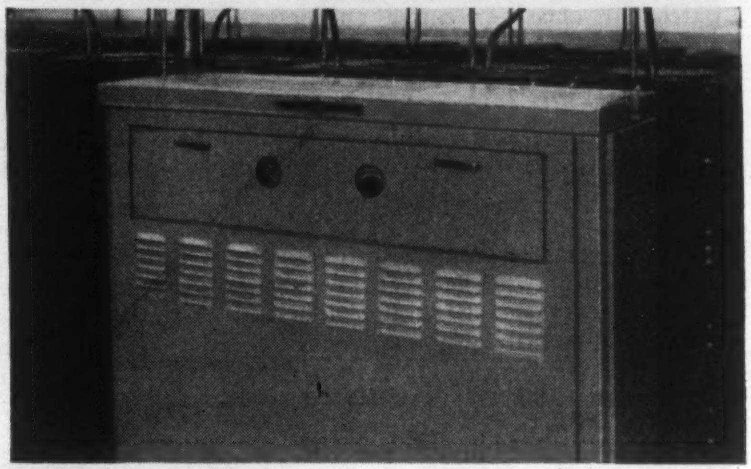
BUY WAR BONDS AND KEEP THEM

GENERAL ELECTRIC



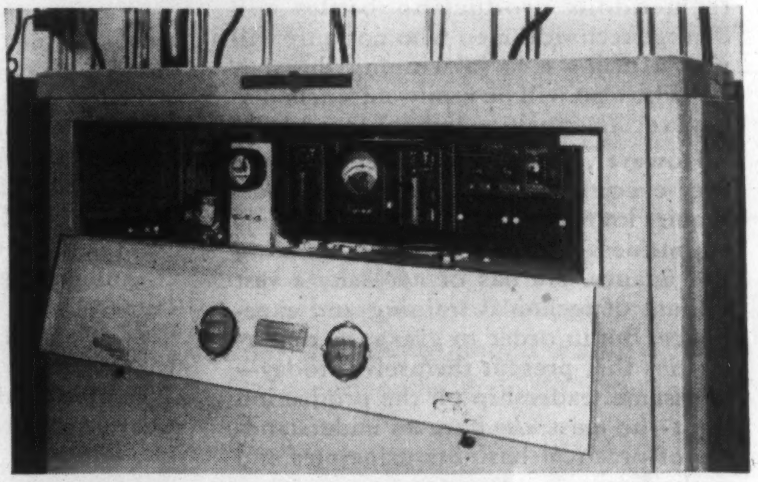
RECTIFIERS

Eighteen G-E "2000" Copper-oxide rectifiers connected in parallel provide output of 5000 amperes 40-volts d-c.



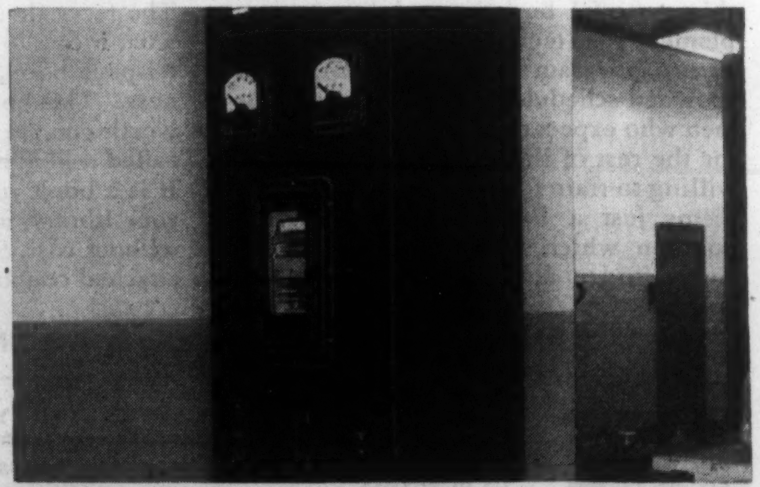
RECTIFIER CONTROL

Fully automatic, easy to use, reduces labor costs. Eliminates "human element" factor and leaves nothing to chance.



RECTIFIER CONTROL ACCESSORIES

Open view of control showing the contact-making voltmeter, the transfer relay, the timer and other accessories.



OPERATOR'S CONTROL PANEL

Located near the tanks for operator's convenience is complete with start-stop push buttons, indicating instruments, recording voltmeter, etc.

(Photographs courtesy of LaSalco Inc.)

An Important Message to

Technical Men

The war has carried the engineering age to a new peak! Production demands have created technical problems the like of which the world has never seen before! The services of engineers are at a premium. Especially the services of one particular class—executive engineers—*engineers with business training;* engineers who can "run the show."

In these critical times, the nation needs engineers of executive ability *now, today*—not five, or ten years from now! The shortage of such men is acute—even more acute than that of skilled production workers. And company heads, aware of this situation, are offering high rewards to engineers who have the necessary training in industrial management.

Golden Opportunity for Engineers

In this new era, the engineer with vision and foresight has a golden opportunity. He will realize that out of today's tremendous production battles will emerge technical men who not only will play a major role in winning the war, but who also will be firmly entrenched in key executive positions when peace comes.

However, before the engineer can take over executive responsibilities, he must acquire knowledge of the other divisions of business—of marketing, accounting and finance. He has of necessity a vast amount of technical training and experience. But in order to grasp the opportunities that present themselves today—to assume leadership on the production front—he must *also* have an understanding of practical business principles and methods.

The Alexander Hamilton Institute's intensive executive training can give you this essential business training to supplement your technical skill. It is a time-saving program that fits into the most crowded schedule. It is not intended for men who expect to remain just engineers for the rest of their lives. It is for those willing to train for the position that now seems just a little beyond them—the position which will increase their incomes today and make their security more certain when the war has ended.

134,000 men on the operating side of business have enrolled for this training. More than 37,500 are technical men—engineers, chemists, metallurgists—many of whom are today heads of our huge war industries.

This training appeals to engineers because it gives them access to the thinking and experience of the country's great business minds. It is especially valuable to such men because it is basic, not specialized—broad in scope, providing a thorough groundwork in the fundamentals underlying *all* business. It covers the principles that every top executive must understand. It applies to all types of industrial organizations, because all types of organizations are based on these same fundamentals.

Business and Industrial Leaders Contribute

The Institute's training plan has the endorsement of leading industrialists and business men. And it is only because these high-ranking executives recognize its value and give their cooperation that such a plan is possible. Among those who contribute to the Course are such men as Frederick W. Pickard, Vice President and Director, E. I. DuPont de Nemours & Co.; Thomas J. Watson, President, International Business Machines Corp.; James D. Mooney, President, General Motors Overseas Corp.; Clifton Slusser, Vice President, Goodyear Tire and Rubber Co. and Colby M. Chester, Chairman of the Board, General Foods Corp.

Send for "FORGING AHEAD IN BUSINESS"

The facts about the Institute's plan and what it can do for you are printed in the 64-page book, "Forging Ahead in Business." This book in its own right is well worth your reading. It might almost be called a handbook of business training. It is a book you will be glad to have in your library, and it will be sent to you without cost. Simply fill in and mail the attached coupon *today.*

SEND FOR THIS FAMOUS BOOK TODAY

Alexander Hamilton Institute
Dept. 271, 71 West 23rd Street, New York 10, N. Y.
In Canada, 54 Wellington St., West, Toronto 1, Ontario
Please mail me without cost a copy of the 64-page book—"FORGING AHEAD IN BUSINESS."
Name..
Business Address..
....
Position..
Home Address..

Water-Resistant Adhesives for Export Containers

Four newly improved water-resistant adhesives, designed for overseas packaging of military parts, have been announced by *Paisley Products, Inc.*, 1770 Canalport Ave., Chicago. Each adhesive has individual characteristics that make it best suited for a particular operation in the manufacture and final sealing of waterproof bags, case liners, and the gluing of V-board export box flaps.

Developed to meet the water immersion tests of Army and Navy packaging specifications, they are currently being used by army depots, arsenals, and war plants whose packaging must conform to such typical specifications as JAN-A-101, C.W.S. No. 197-54-398, U.S.A. No. 100-14A, etc.

These four are: Paisley No. 3130—a reclaim rubber and resin emulsion, with retack features, designed for quick bonding of case liner and waterproof bag stocks. Paisley No. 4016—asphalt and rubber emulsion, with retack features, for hand brush application to large case liners and bags. Medium fast setting. Paisley No. 676—vinyl polymer emulsion, for fast hand or machine sealing of V-boxes, small cartons, case liners, and bags. Paisley No. 688—vinyl polymer-starch adhesive. Hand brush sealing of V-board cartons, and cases, where good suction is necessary and final drying is accomplished under pressure.

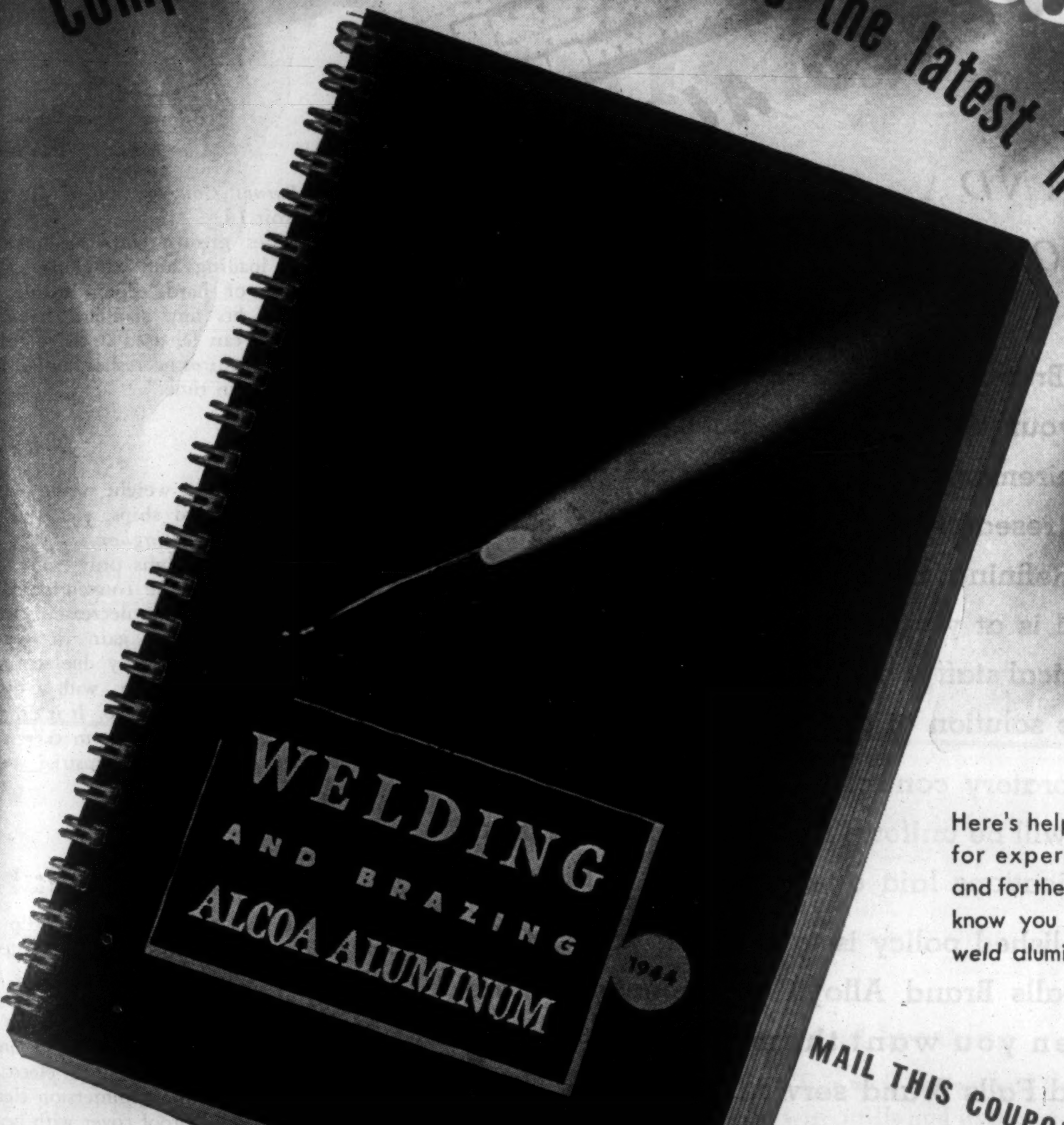
These adhesives are of the emulsion type, the adhesive and resin solids in the form of tiny particles or droplets being suspended in a water solution. They are non-inflammable, free from objectionable odors, and permit fast sealing as they can be water diluted to spread freely and evenly without brush drag. When used on asphalt laminated and impregnated papers and V-board, the fast breaking emulsion quickly penetrates the paper fibres and releases the resin film as the water insoluble bonding agent.

The final adhesive film, when completely dry, is resistant to extremes of heat, cold, humidity, and complete water immersion with a safe margin over the usual specification tests.

- Korolac RX solution, used in covering plating racks either by itself or with Koroseal Tape RX, is now being made in white instead of the clear color originally furnished, it is announced by the *B. F. Goodrich Co.*, Akron, Ohio. Used as a stop-off lacquer, the white is clearly visible and the operator has no difficulty in determining just what portions of a part have been masked. When covering new plating racks, the white solution shows plainly whether all parts of the rack have been covered. It has the same chemical resistant properties as the clear type, and gives a slightly heavier coat per dip. It provides a corrosion resistant, tough, inert coating with good insulating properties. Liquid at room temperature, it holds its position on the rack, after dipping or painting, because of shrinkage as the solvent evaporates.

IT'S NEW!

Completely revised to include the latest "how-to-do-it" data



Here's helpful information for experienced workers and for the man who "didn't know you could weld aluminum."

ALCOA

MAIL THIS COUPON TODAY . . .

ALUMINUM COMPANY OF AMERICA
2162 Gulf Building, Pittsburgh 19, Pa.
Send me the revised edition of WELDING and BRAZING ALCOA ALUMINUM

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Company______________________________
Address_______________________________

ALCOA
FIRST IN
ALUMINUM

Falls
ENGINEERED ALLOYS

WHERE AND
WHEN YOU WANT THEM...

... Falls Brand alloys are just that—engineered to meet your specifications exactly or to meet your requirements when alloy problems arise. The alloy research data at Niagara Falls Smelting and Refining Corporation is accurate, thorough, and is at your disposal. The laboratories and technical staff are ready at all times to assist you in the solution of any alloy problem.

Rigid laboratory control assures you that every shipment will be uniform in quality and will meet the specifications laid down.

Our established policy is to see that you get the Quality Falls Brand Alloys you specify, where and when you want them. You'll find Falls Brand service fully dependable in meeting the most critical production schedules.

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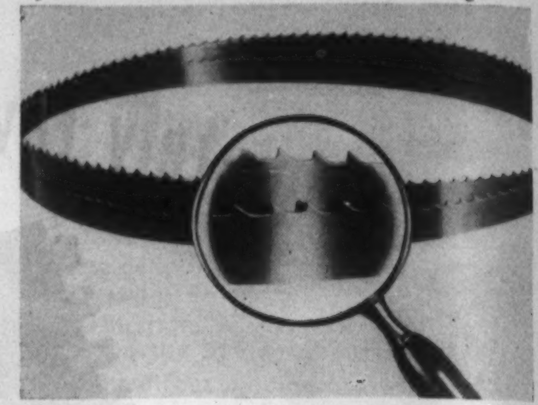
NIAGARA FALLS SMELTING &
REFINING CORPORATION
America's Largest Producers of Alloys
BUFFALO 17, NEW YORK

Skip Tooth Band Saw

A new skip tooth band saw of special design for faster, easier cutting of magnesium, aluminum, soft brass and other non-ferrous metals, as well as plastics, composition, fibre and wood, is introduced by *W. O. Barnes Co., Inc.*, 1297 Terminal Ave., Detroit 14.



It provides greater chip clearance and eliminates loading and clogging of the teeth. It is of hard edge, flexible back construction, fits any standard band saw machine, and can be used until completely worn out. It requires no resharpening, hence minimum "down time."

- A new d.c. light weight welder for use by the Navy aboard ships, etc., has been brought out by *Westinghouse.* This 200-amp. d.c. welder weighs only 333 lb., as against 500 lb. for the conventional 150-amp. welder. Thus, a ⅓ decrease in weight is accompanied by ⅓ gain in capacity. Weight reduction is mostly due to an improved ventilating system, with emphasis on the underside of the core. It is on skids, with handrail for four men to carry. The welders are available for industrial use.

Hot Dip Plastic Coating Tank

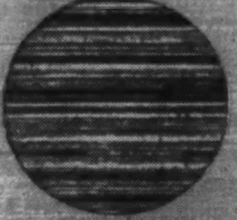
A small tool room model hot dip tank for melting plastics to form skin protective coatings over steel parts for overseas shipment is announced by *Aeroil Burner Co.*, W. New York, N. J. Known as the "Plast-O-Dip" Model 3, it is built on the double-boiler principle and is electrically heated with a 1200-watt immersion element encased in a liquid proof cover with heating coils sealed within steel blades. This element delivers heat into an oil bath that completely surrounds the inner vat containing the compound, thus providing indirect heat.

The temperature of this hot oil bath is rigidly controlled from 100 to 550 F. by a built-in housing containing a thermostat with knob dial and pilot light. A dial thermometer is included. Extra heavy insulation minimizes heat loss. A two-prong plug and 7 ft. of cable allow it to be plugged in anywhere.

Dipping space is 16 in. long x 6½ in. wide and 6 in. deep. There is a separate melt section with a removable dividing partition of expanded metal to permit adding new compound without disturbing operations. There are two sizes.

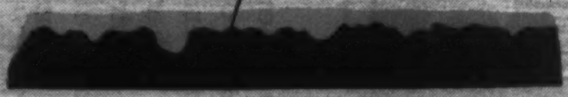
CUPRODINE

FACILITATES DRAWING



A polished steel surface when magnified appears rough — covered with pin points and file-like ridges.

A cross section of these ridges more highly magnified might be illustrated as above.



When Cuprodized, the sharp ridges are dissolved and surface coated with copper insuring longer die life and improved products.

Assures longer die life—less scoring and breaking

CUPRODINE (copper) coatings are unique in that the Cuprodine bath reacts chemically with the steel, dissolving the microscopic surface ridges and points which protrude through most drawing compounds, scratching and ruining the dies.

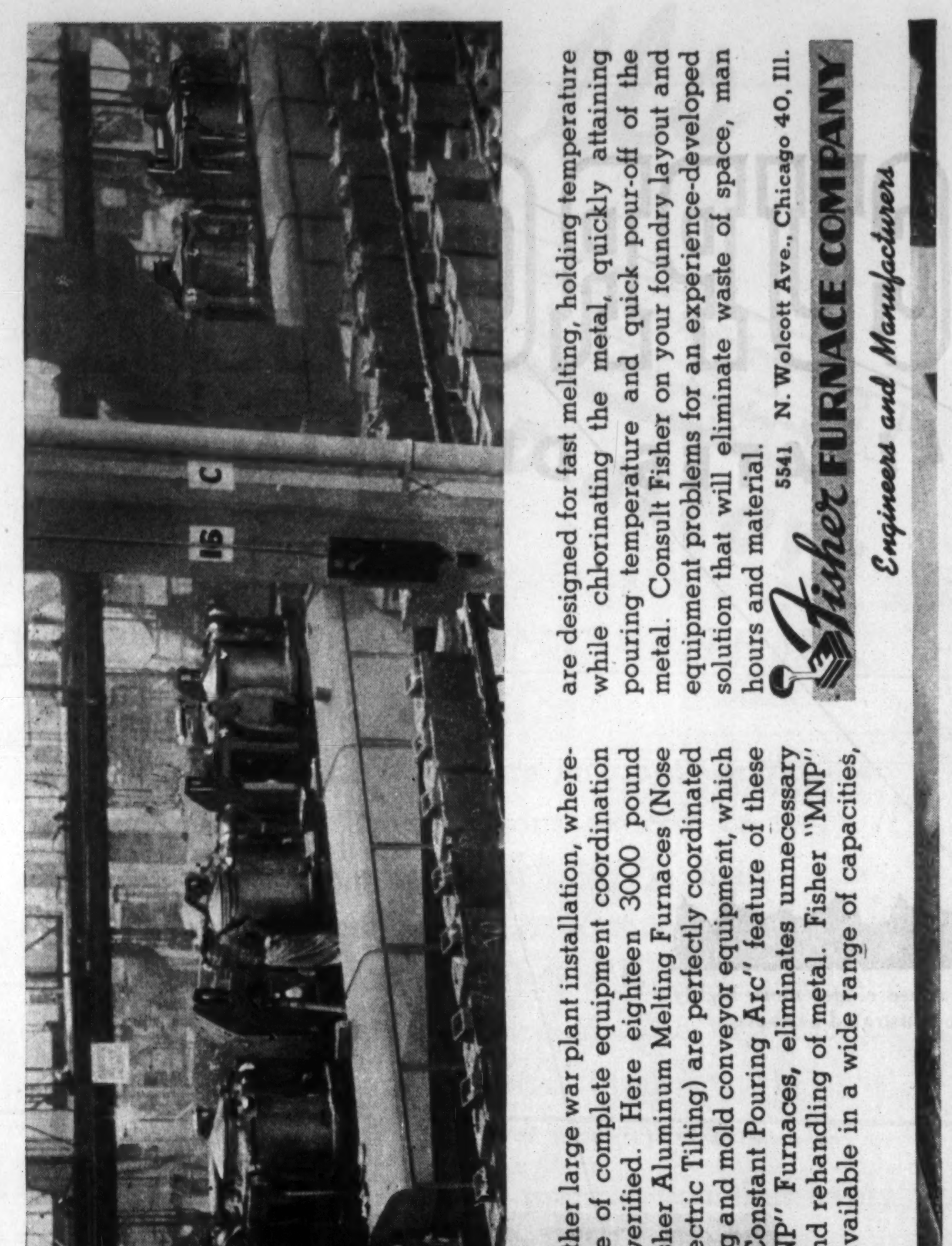
A chemical reaction causes copper to plate out of the solution (without current), producing a thin tight copper coating that provides an ideal prelubricating surface insuring longer die life-improved drawing.

CUPRODINE is well known and has been generally adopted in wire mills and in the production of small arms steel shell cases. There is a large field in other industries where the economy and efficiency of this new method can be applied. Further information regarding the adaptability of Cuprodine to your particular needs will be furnished by our Technical Laboratories. Write dept. G-4.

MANUFACTURERS OF INHIBITORS AND METAL WORKING CHEMICALS

AMERICAN CHEMICAL PAINT CO.
AMBLER ACP PENNA.

Note—West Coast Plants may address inquiries and orders for prompt delivery to Leon Finch, Ltd., 728 East 59th St., Los Angeles, California.



Fisher PROVES IT AGAIN!

Here is another large war plant installation, wherein the value of complete equipment coordination has been verified. Here eighteen 3000 pound capacity Fisher Aluminum Melting Furnaces (Nose Pouring, Electric Tilting) are perfectly coordinated with pouring and mold conveyor equipment, which with the "Constant Pouring Arc" feature of these Fisher "MNP" Furnaces, eliminates unnecessary handling and rehandling of metal. Fisher "MNP" Furnaces, available in a wide range of capacities, are designed for fast melting, holding temperature while chlorinating the metal, quickly attaining pouring temperature and quick pour-off of the metal. Consult Fisher on your foundry layout and equipment problems for an experience-developed solution that will eliminate waste of space, man hours and material.

5541 N. Wolcott Ave., Chicago 40, Ill.

Fisher FURNACE COMPANY
Engineers and Manufacturers

Remember, if it's Monarch Equipment (or parts) —it's now made by Fisher, since our purchase of the furnace business of Monarch Engineering & Mfg. Co.

Electronic-Controlled Miller

A combination of electronic and hydraulic control features a special machine for milling the circular, partial and dome fins on a forged aluminum airplane cylinder head, designed by the *Sundstrand Machine Tool Co.,* Rockford, Ill. This machine will handle in two operations the milling of the same number of fins that formerly required four machines and four separate operations. Actually, circular and partial fins are milled in one operation. Dome fins require change in cams, the cutter and workholding fixture.

The path followed by the cutter is very irregular, changing in shape and depth for each successive fin. The automatic electronic feed control keeps the fragile cutter loaded to full capacity. Where cut is light, the rate of feed increases; where cut is heavy, the feed rate decreases. The rate of feed varies within a range of 6 to 60 in. per min.

The machine has a complete automatic cycle after loading. Master cams and work part are mounted on a splined shaft, thus eliminating the possibility of error between the rotation of the cams and of the part. The work part is rotated through its feed and rapid traverse cycle by an electrically controlled mechanical feed box.

The operator can run one or more machines if desired. Adjustments are positive and the cutter can be set to rapid approach to within 1/8 in. of each fin.

● Two holdouts among metals defying electroplating, one of the most useful of engineering tools, have at last capitulated to *Westinghouse* engineers. Beryllium and tantalum do not respond to usual electroplating techniques. Methods have been found for plating beryllium and tantalum from fused salt baths. Tantalum-plated anodes in vacuum tubes offer possibilities of low secondary emission, and as an absorber (getter) of stray gases.

Inexpensive Dust Collector

A suitable dust collector at a reasonable price for use with grinders, lathes and other machines is sponsored by the *Ideal Commutator Dresser Co.,* 1928 Park Ave., Sycamore, Ill. Being compact, it readily fits beside machines as they stand, eliminating relocation of machines, separate rooms, expensive ducts, etc.

A capacity of 500 cu. ft. per min. is developed through the two inlets by a 3/4-h.p. 3450 r.p.m. motor, driving a 7½-in. diam. by 2-in. wide squirrel cage blower wheel. Dust and air are whirled around at high speeds in twin cyclone separators, the heavier dust dropping into the dust drawer. The lighter air passes on through a viscous coated filter where fine dust is removed, clean air coming back into the room.

The filter consists of 20 layers of viscous coated filter paper, one peeling off the first two layers periodically to present fresh filtering surfaces, one filter lasting a year.

"...maybe...

but we'd better ask HOUGHTON"

When you're in doubt as to the surest method to use for a certain heat treatment, it's good to know that there is one source you can depend upon for sound advice.

Houghton has made heat treating products and supplied counsel on practical methods for the past 75 years. The Houghton Man who calls on you is well versed in both product and application data, and is backed by an organization of metallurgical engineers who are at your service.

You are invited to use this aid whenever processes involving carburization, quenching, hardening, tempering, reheating or treating high speed steels are under discussion in your plant.

E. F. HOUGHTON & Co.
PHILADELPHIA
CHICAGO SAN FRANCISCO DETROIT

HOUGHTON'S *Liquid* SALT BATHS

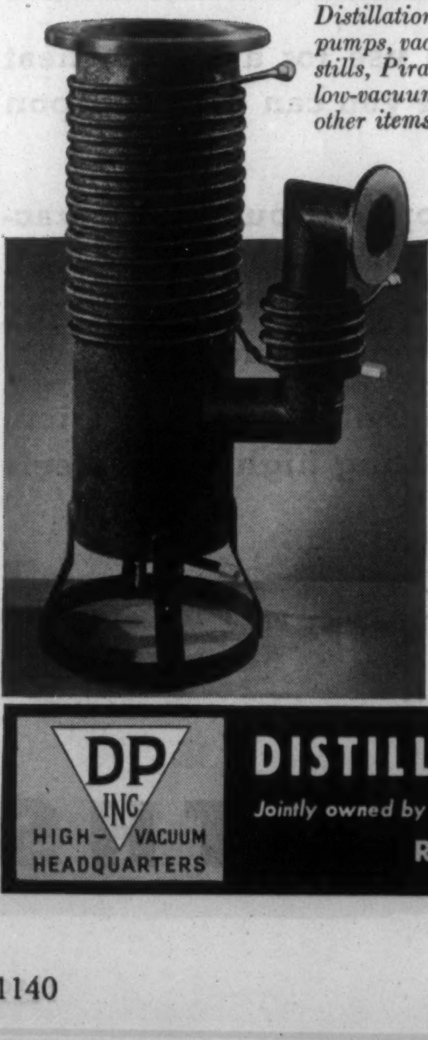
2 Booster Type . . . All-Metal High-Capacity Vacuum Pumps

THE Distillation Products two-stage Metal Booster Pumps *Types MB-200* and *MB-200G* are specially designed for use with large forepumps having a low volumetric efficiency at pressures below .5 millimeter. They are recommended for large vacuum systems in which a high pumping speed at .1 to 10 microns pressure is desired, or as a booster stage between a mechanical pump and an extremely high-speed diffusion pump. Typical applications are the vacuum smelting of magnesium, the high-vacuum drying of organic materials, and the vacuum impregnation of materials.

A vacuum in the order of 5×10^{-5} millimeter is obtainable with Butyl Phthalate or Butyl Sebacate. Other pumping fluids of even greater stability are available which give vacua of approximately 10^{-4} millimeter and permit operation against .4 millimeter backing pressure. A 1000-watt immersion-type heater is provided in the *MB-200* model, while gas burners adapted for any gas can be furnished in the *Type MB-200G*. Special features such as thermostatic controls, sight glasses, baffles, and threaded forepump connections can be incorporated when requested.

SPEED	**200 l/s. at 5×10^{-4} mm. Hg**
ULTIMATE VACUUM	**5×10^{-5} mm.**
MAXIMUM FOREPRESSURE	**0.5 mm.**
HEATER INPUT	**700 watts**
PUMPING FLUID	**Butyl Sebacate**
HEIGHT	**23½ in.**
DIAMETER	**6 in.**

Further data on these two pumps is available on request . . . General catalog contains information on the complete Distillation Products line of diffusion pumps, vacuum coating units, molecular stills, Pirani gauges, Ionization gauges, low-vacuum-pressure fluids, greases, and other items for high-vacuum technology.



Write Vacuum Equipment Division.

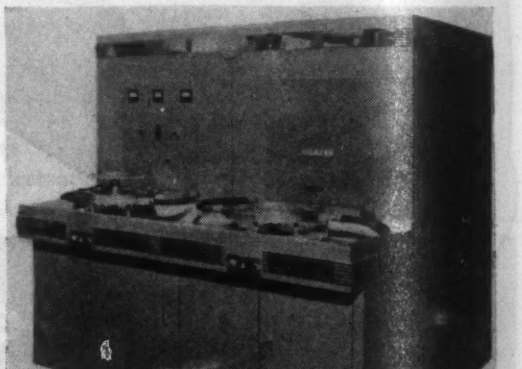
DP INC
HIGH-VACUUM HEADQUARTERS

DISTILLATION PRODUCTS, INC.
Jointly owned by EASTMAN KODAK COMPANY and GENERAL MILLS, INC.
ROCHESTER 13, N. Y.

● A new plastic blind rivet permitting one-man operation and blind fastening is sponsored by *Plastic Development Div., Victory Mfg. Co.,* 1105 Fair Oaks Ave., S. Pasadena, Calif. The design of the "Des-Rivet" is based on a wedging action, and takes advantage of flow characteristics of plastics under pressure. They are molded as one piece, consisting of a head with plug attached by a thin breakaway section and a tapered shank split to form four tapered fingers. Shank and head are hollow to the same diameter as the plug. They may be singly inserted or assembled in "sticks" by inserting the undriven plug of one rivet into the shank of another. Choice of colors makes for decorative effect.

50-Kw. Electronic Heater

A new 50-kw. electronic heater for surface and localized hardening of gears, rods, and other parts and for annealing, brazing, and soldering operations, has been announced by *Industrial Heating Div., General Electric Co.* Ideal for use in metal-working plants, the new heater incorporates all of the important features of the 5-kw. and 15-kw. G-E heaters, and can heat-treat much larger parts or the same size parts in less time. This heater is readily applicable for many different heating jobs merely by changing the induction-coil fixture.

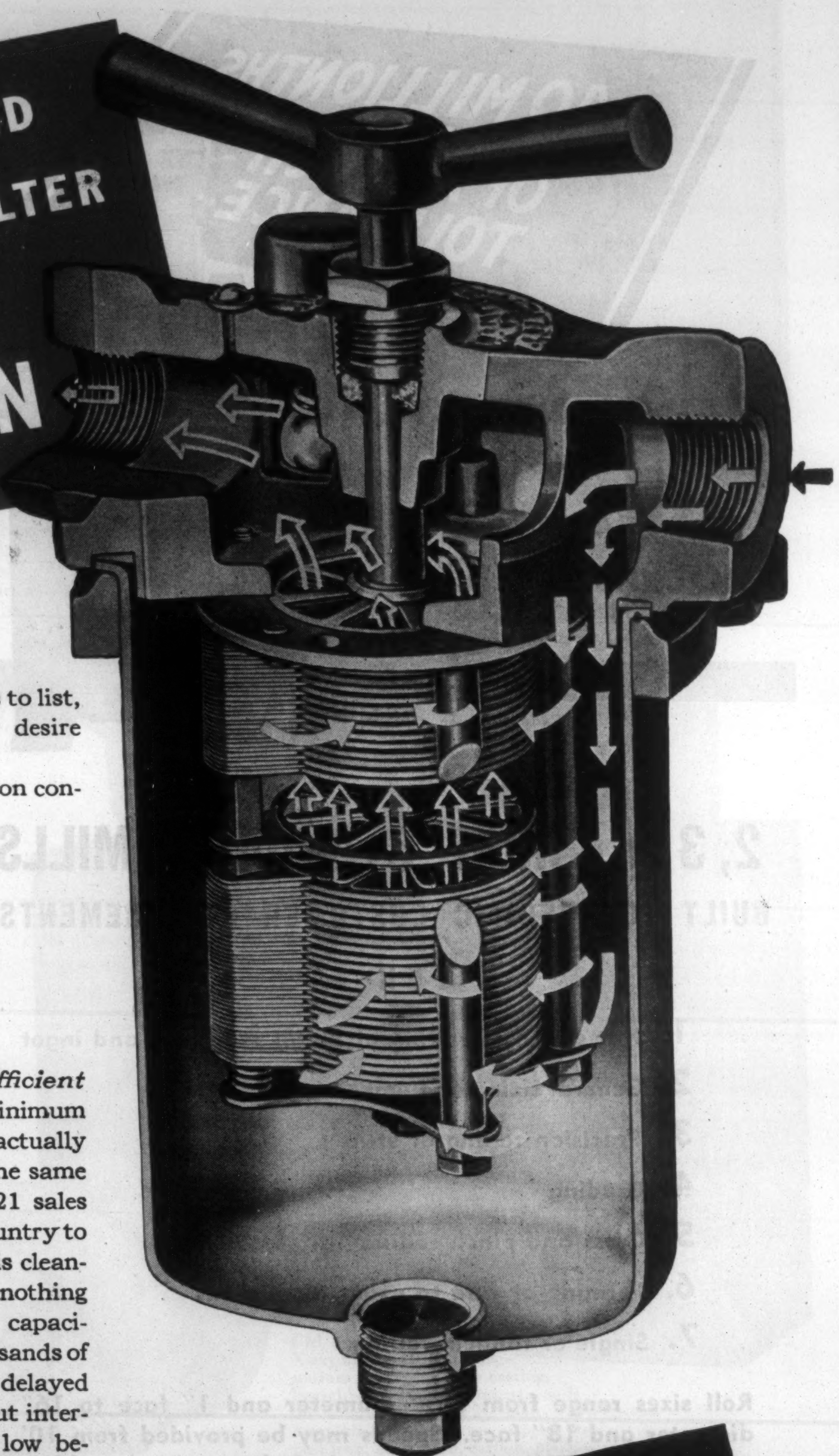


Available in models rated either 230 or 460 volts, 3 phase, 60 cycles, it is unusually easy to operate. Parts are positioned in the fixture, and the start button is pressed. Automatic controls then regulate the heating and quenching cycles, assuring duplication of results on each part. An attached work table provides two heating positions, permitting full utilization of the high-frequency power supply to secure maximum production.

Completely enclosed in grounded steel, which minimizes radiation and affords protection for the operator, the entire unit weighs approximately 6000 lb. and is 84 in. wide, 94 in. deep, and 82 in. high overall. The electronic heater cabinet is composed of two compartments, one with an air-cooled transformer to step-up power supply voltage to the six rectifier tubes, and such accessory items as a contactor, a tap-changing switch, and filament transformers; the other, the high frequency components—a single water-cooled oscillator tube and a bank of water-cooled capacitors.

WHAT YOU'VE SAID YOU WANT IN A FILTER YOU GET IN AN

AUTO-KLEAN



WE asked a large number of manufacturers to list, in order of importance, the features they desire most in a fluid-cleaning device.

Here's what the men in charge of production considered most important:

1. Efficiency
2. Simplicity and compactness
3. Service from supplier
4. Ease of maintenance
5. Capacity
6. Continuous operation
7. Maintenance cost

Now consider the Cuno Auto-Klean. (1) It's *efficient*—positively stops all solids larger than minimum size specified. (2) It's simple and *compact*—actually smaller in size than other filters handling the same volume at equal porosity. (3) There are 21 sales engineering organizations throughout the country to provide service. (4) It's easy to maintain—is cleanable just by turning a handle, or by motor—nothing to replace or remove for cleaning. (5) Flow capacities range from a fraction of a gallon to thousands of gallons per minute. (6) Production is never delayed—the filter is continuously cleanable without interfering with flow. (7) Maintenance cost is low because the all-metal filter element will last as long as the equipment on which it is installed.

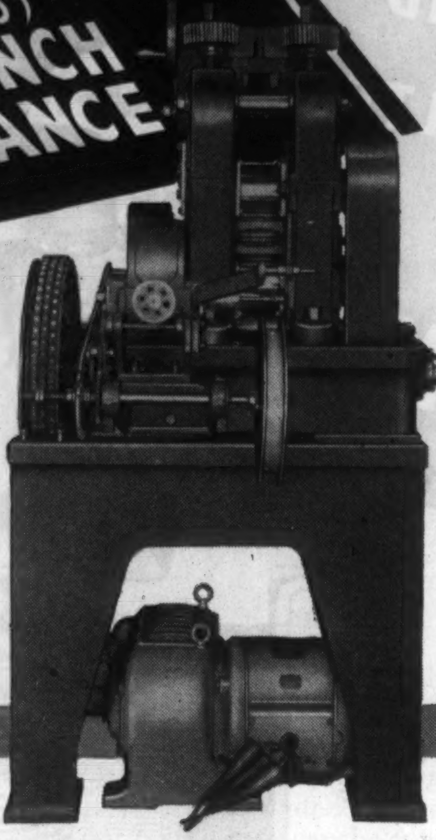
Cuno Auto-Klean—an all-metal, non-collapsible filter—is being used successfully on a variety of applications . . . from high-pressure to gravity-feed systems . . . from straining river water to filtering heaviest fuel oil.

You'll find filter selection information and specifications on the Cuno Auto-Klean in SWEET'S—or write us for Mechanical and Process Industries Catalog, Cuno Engineering Corporation, 454 South Vine Street, Meriden, Connecticut.

KEEP FLOW ON "GO" WITH

CUNO

THE "FILTER-FINE" STRAINER



40 MILLIONTHS (.000040) OF AN INCH TOLERANCE

MAINTAINED BY THIS 4-HIGH *"Standard"* ROLLING MILL

Extra Precision 4-High Light Duty Mill.

2, 3 or 4 HIGH "STANDARD" MILLS

BUILT TO SPECIFIC CUSTOMER REQUIREMENTS

FOR—

1. Hot and cold rolling of metal strip, rod and ingot
2. General sizing and embossing
3. Precision rolling of strip
4. Grading
5. Cross and pinch rolling
6. Forming of wire to exact dimensions
7. Single or tandem rolling

Roll sizes range from 1½" diameter and 1" face to 16" diameter and 18" face. Speeds may be provided from 10' to 500' per minute. Attachments include running-in tables, single, double and triple edgers, payoff reels, takeup reels, straighteners and Turks Heads.

Write for Catalog Section RM

STANDARD MACHINERY CO.

1542 ELMWOOD AVENUE, PROVIDENCE 7, R. I.

Weld and Sequence Timer

A new weld and sequence timer for providing the various time and current adjustments necessary for welding heavy sections of air-hardenable steels, has been announced by the *Industrial Control Div., General Electric Co.* Although this timer, known as Type CR7503-F170, is especially designed for use with a G-E ignitron contractor and a heat control panel, it can also be used with most G-E spot-welding controls, which include the phase-shift method of heat control.

Operating from 230/460/575 v., 60 cycles, the control adjusts the time of current flow and its magnitude for preheating, welding, grain refinement and tempering. Other adjustments control the time for chilling the weld nugget following the weld and grain refinement periods. For variations in control voltage of +10 to -20%, consistency of timing will be within plus or minus ½ of 1% of the time setting.

It is recommended that a G-E current regulating compensator be used with this combination to correct for variations in welding current caused by line voltage variation or the introduction of magnetic materials into the throat of the welding machine.

This control consists of nine time intervals, seven independent heat adjusters, two pressure interval timers, one squeeze timer, one hold timer, and provisions for a two-stage foot switch, all housed in a steel enclosure. Control adjustments are easily accessible on the front of the panel, and each timer has a separate time adjustment and an indicating light, which gives a quick indication of which timer is in operation.

The heat control potentiometers have large graduated dials that enable accurate heat settings. A minimum number of tubes (6) are used to give the multiplicity of operations required.

Heating Pot for Low Melting Point Materials

A new heating pot for low melting point materials, such as fusible metals, originally designed as a glue pot for patternmaking and woodworking shops, is announced by the *Kindt-Collins Co.,* 12651 Elmwood Ave., Cleveland. It melts and maintains liquidity for such diverse materials as shellac, kerosene, turpentine, waxes and certain plastics. It is electrically heated, completely automatic, wet, fire and explosion proof.

Its heating element, thermostatically controlled, operates with a vacuum-sealed fluid that circulates between the outer and inner shells of the pot and transfers equal heat to all parts of the material being heated. After the vacuum shell of the pot has its air drawn out, the resulting vacuum is filled with a fluid that never requires replacement.

There are no hot spots to cause drying of the material. Current consumption averages only 0.6 of 1 kw. per 8 hr. day with a full pot. It comes to maximum temperature from a cold start in 30 min. The current is on one quarter of the time.

The temperature range is 142 to 162 F. Its capacity is 2 quarts, and is cylindrical in shape.

Better Products at Lower Cost with

SEARCHRAY 150

Self-contained Industrial X-ray

The NORELCO Searchray Model 150 (Industrial X-ray) Unit pays its own way in any plant through the savings it brings in over-all production costs. It permits control of product quality, and often leads to improved manufacturing techniques by instantly revealing hidden defects that can be corrected *before* production begins.

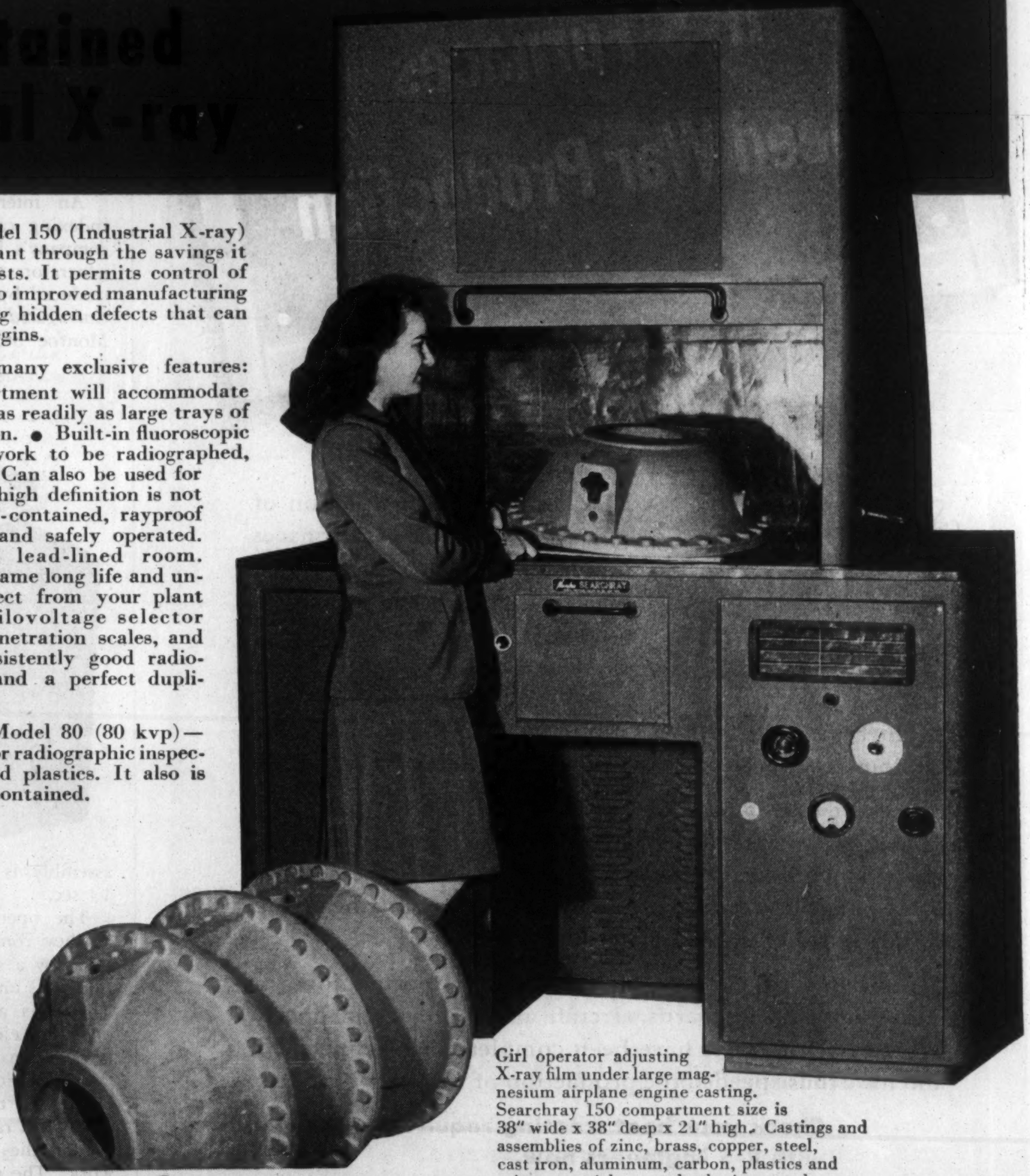
Searchray 150 (150 kvp) has many exclusive features: ● Spacious specimen compartment will accommodate bulky castings and assemblies as readily as large trays of small parts for group inspection. ● Built-in fluoroscopic unit permits previewing of work to be radiographed, saving time and film expense. Can also be used for fluoroscopic inspection where high definition is not required. ● Completely self-contained, rayproof and shockproof, it is easily and safely operated. ● Eliminates expense of lead-lined room. ● High safety factor insures same long life and uninterrupted service you expect from your plant machinery. ● Stepless kilovoltage selector with three direct-reading penetration scales, and automatic timer, insure consistently good radiographs of most materials and a perfect duplication of results.

A smaller unit — Searchray Model 80 (80 kvp) — is available for the fluoroscopic or radiographic inspection of light metal sections and plastics. It also is rayproof, shockproof and self-contained.

Let Searchray solve *your* inspection and production problems and improve your competitive position. Send coupon today for descriptive literature.

NORELCO ELECTRONIC PRODUCTS also include X-ray Diffraction Apparatus; Medical X-ray Equipment, Tubes and Accessories; Quartz Oscillator Plates; Amplifier, Transmitting, Rectifier and Cathode Ray Tubes; Tungsten and Molybdenum products; Fine Wire; Diamond Dies.

We invite you to visit our office and showroom when in New York City



Girl operator adjusting X-ray film under large magnesium airplane engine casting. Searchray 150 compartment size is 38" wide x 38" deep x 21" high. Castings and assemblies of zinc, brass, copper, steel, cast iron, aluminum, carbon, plastics and other materials may also be inspected radiographically and fluoroscopically.

Norelco
Reg. U. S. Pat. Off.
ELECTRONIC PRODUCTS by

NORTH AMERICAN PHILIPS COMPANY, INC.

Executive Offices: 100 East 42nd Street, New York 17, N. Y.
Factories in Dobbs Ferry, N. Y.; Mount Vernon, N. Y. (Metalix Division)
Lewiston, Maine (Elmet Division)
Represented in Canada by Philips Industries, Ltd., Sun Life Bldg., Montreal, Centre 2;
In England by Philips Lamps, Ltd., Century House, Shaftesbury Avenue, London, W.C. 2.

North American Philips Co., Inc.
100 East 42nd Street, New York 17, N. Y.
Gentlemen:
Kindly mail literature on Searchray Models 80 and 150 to:

Name____________________
Title____________________
Company____________________
Address____________________

Dept. M-4

R-S Furnaces
Speed War Production

R-S
QUALITY PRODUCTS
SINCE 1908

The design and construction of industrial heat treating furnaces involve the interlocking of metallurgical and mechanical principles. It is R-S policy to give every furnace problem the personal attention of our chief engineer and his staff and to recommend the most efficient equipment consistent with sound economy.

Because of this personalized attention, R-S has been able to suggest changes in construction which have more adequately met industrial requirements and, in many cases, has made possible reduced costs, quicker delivery and the saving of quantities of critical materials.

R-S Industrial Furnaces are now doing important jobs for steel foundries, shipyards, aircraft and ordnance plants. In every case, contracts have been completed when specified, and have thus speeded the production of vital war products.

✓ **Check your heat treating requirements with R-S Engineers now.**

R-S Furnaces of Distinction

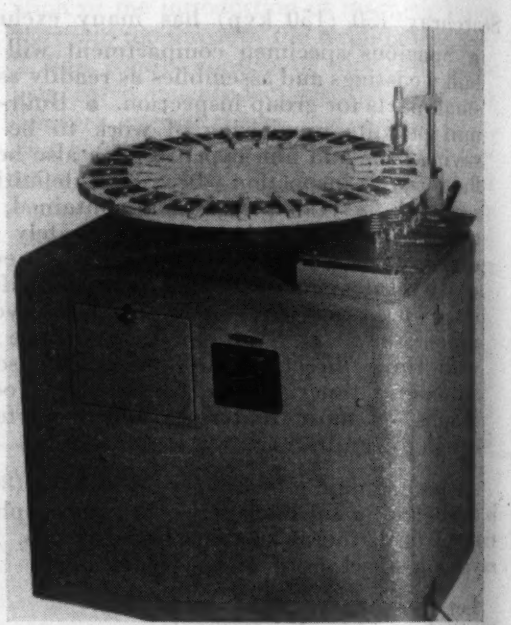
FURNACE DIVISION
R-S PRODUCTS CORPORATION
4522 Germantown Avenue • Philadelphia 44, Pa.

BUY WAR BONDS

● Felt bobs, permanently mounted on ⅛-in. or ¼-in. steel mandrels, for polishing, finishing and deburring metals, plastics, etc. are announced by *Bacon Felt Co.*, Winchester, Mass. When the felt has worn out, the operator simply slips one of the new mounted bobs in place, no time being wasted in removing the felt stub from the mandrel and fitting a new one on the old mandrel. Called the Paramount brand, they are used with portable air or electric tools, flexible shaft equipment, drill presses, lathes, etc. The bob has been trued up and securely attached at the factory, thus saving time.

Indexing Work Carrier for Brazing

An interesting new 24-station circular indexing carrier, mounted on one of the company's 18 kw. electronic high frequency generators to braze metal assemblies is introduced by *Scientific Electric, Div.* of *"S" Corrugated Quenched Gap Co.*, 107-119 Monroe St., Garfield, N. J. A complete assembly is ejected from the carrier each 12 sec.



The operator merely loads the stations as they come around empty. Heat is applied by a set of three water-cooled induction coils under three of the work positions. The coils are followed by the vertically-operating ejecting mechanism. Carrier drive is by a small motor.

Application of the carrier can be made on any of the company's electronic generators with ratings of 5 to 100 kw., depending on the heat-input requirements of the work. The normal output of the unit is at 200 to 600 kilocycles.

● Recording vibrations far removed from laboratory facilities can be accomplished by the "Vibrograph," put out by *Westinghouse Electric & Mfg. Co.*, East Pittsburgh, Pa. It weighs under 9 lb. and needs no power connections. It writes a permanent record of vibrations from 600 to 15,000 cycles per min. and amplitudes down to one ten-thousandth of an in., or as great as 1/16 in. A stylus draws the record and timing wave on a transparent plastic tape, viewed by a low power microscope. It uses the same principle by which earthquakes are recorded.

LINQINGS FOR FURNACES WITH CONICAL SHELLS ARE FITTED TO GAUGE. ASSEMBLED AND MATCH MARKED BEFORE SHIPMENT. CONSEQUENTLY TAYLOR-MADE LININGS MAY BE INSTALLED WITH A MINIMUM DELAY.

P. B. SILLIMANITE

for Detroit electric furnaces

Detroit electric furnaces which are lined with P. B. Sillimanite Brick and Special Shapes are setting new records for long life, efficient operation, lower refractory costs per ton of metal produced. Lining life may be extended by maintaining with one of the P. B. Sillimanite plastics and cements engineered for the job.

TAYLOR ZIRCON LININGS OFFER INTERESTING POSSIBILITIES FOR MELTING HIGH TEMPERATURE METALS IN DETROIT ELECTRIC FURNACE.

CHAS. TAYLOR SONS Co.

MANUFACTURERS OF REFRACTORIES • CINCINNATI • OHIO • U. S. A.

"Metal Parts are Critical Essential Products" SO WHAT? *when all plants are handicapped by the severe LABOR SHORTAGE*

IF it's impossible to get sufficient help to produce your orders, consider this:

Pangborn equipment, handling work by the conveyor hook method, will increase the tonnage per man in your cleaning room operations several hundred percent.

Photograph reproduced is a typical ROTOBLAST* installation in Mid-West customer's plant. Castings shown weigh from 75 pounds to 1200 pounds each. The work cleaned with this installation averages *35,000 pounds per hour.*

Simplicity of operation is shown by these three steps:

1. **Hang castings on conveyor hooks**
2. **Castings travel through ROTOBLAST Cabinet**
3. **Thoroughly cleaned castings delivered to chippers and grinders in continuous flow at pre-determined speed.**

If you have a labor shortage problem—big or little—"Come to Pangborn!"

**Trade-mark of Pangborn Corporation*

PANGBORN

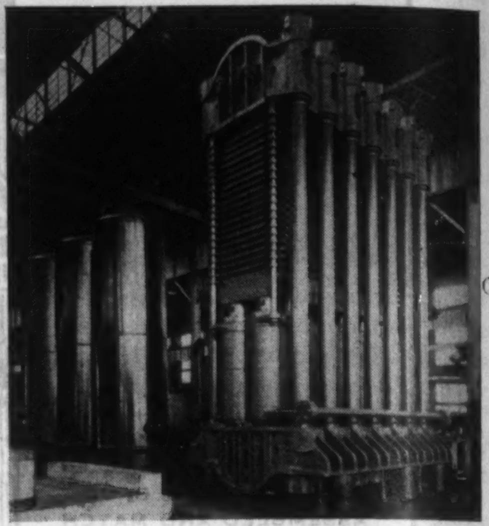
WORLD'S LARGEST MANUFACTURER OF DUST COLLECTING AND BLAST CLEANING EQUIPMENT

PANGBORN CORPORATION • HAGERSTOWN, MD.

Giant Press for Fiberboard

A giant steam platen press to form fiberboard under intense heat and pressure of 9,500 tons was designed by the *Southwark Div., Baldwin Locomotive Works.* It can form 20 boards at one time, each board 4 by 16 ft., and with pressure of 2,500 tons per sq. in. on each board.

The 21 steam plates are drilled with 60 passages for steam circulation. The product of the press is used for electric panels and for stamping dies, wallboards, etc.



The press itself weighs 1,250,000 lb., and is the largest of this type ever produced. Some of its individual castings weigh as much as 140,000 lb. Its 14 hydraulic cylinders have a 6-ft. stroke and are made by the *Standard Steel Works,* Baldwin subsidiary, while *Cramp Brass,* another subsidiary, made the bronze and iron bushings.

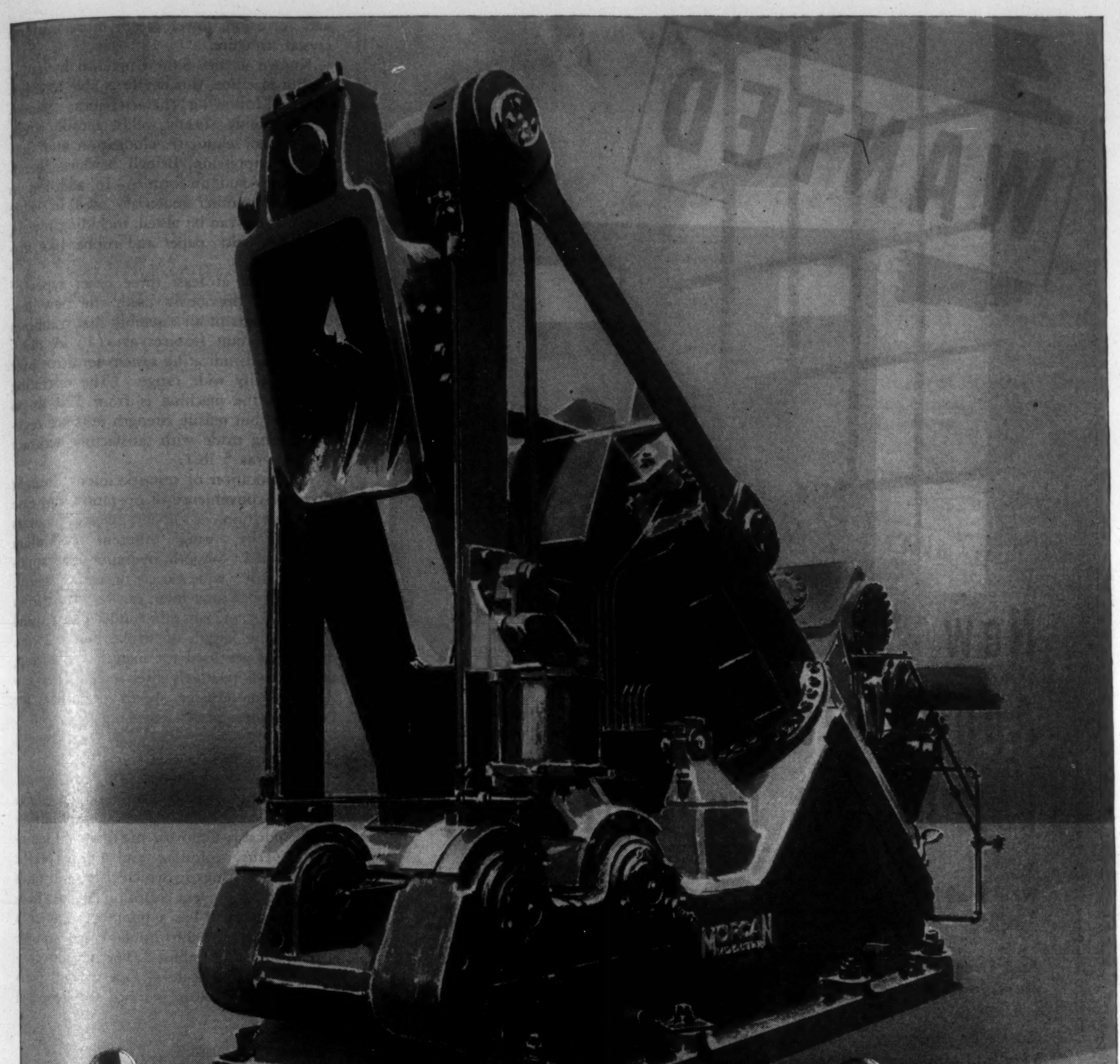
Like other Southwark presses for rolling and forming duralumin or aluminum plates and extruded shapes for the aircraft industry and other industries, this press represents a new step forward toward post-war manufacturing in a long line of powerful hydraulic presses that are used today by industries around the world.

● Three types of new solid polishing wheels, with relatively soft and flexible bond that imparts a cushion-like action, assuring a smooth uniform finish, have been brought out by *Norton Co.,* Worcester, Mass., and are called "Norflex." One type is cork resinoid, another fiber resinoid and the third resilient rubber. They remove only a relatively small amount of material, such as a burr or sharp edge, or polish a surface that is already to size.

Machine to Test Lead in Cables

Radically new design features are built into a test machine recently installed in the research laboratories of the *Okonite-Callender Cable Co., Inc.,* Paterson, N. J., for studies on lead cable sheaths. The machine checks the response of this metal to various treatments and chemical composition whether "as purchased" or deliberately "built" into the lead to develop specific characteristics, such as resistance to fatigue

(Continued on page 1148)



FLYING SHEAR
125,000 POUNDS
17 FEET HIGH
MORGAN
CONSTRUCTION CO.
WORCESTER, MASS.

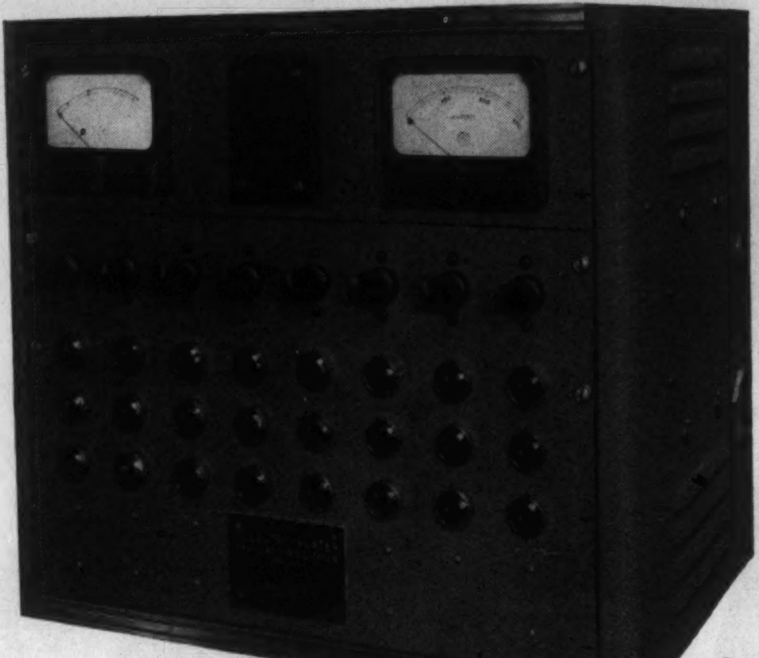
PLAN NOW WITH

MORGAN

ENGINEERS AND BUILDERS OF ROLLING MILLS
WIRE MILLS • GAS PRODUCER MACHINES
REGENERATIVE FURNACE CONTROL

ENGLISH REPRESENTATIVE: INTERNATIONAL CONSTRUCTION CO., 56 KINGSWAY, LONDON, W. C. 2, ENGLAND

WANTED



*

New Applications for Direct Current...

What's on your mind? If it has to do with D.C. power, Green Engineers will come up with the answer.

And Green will not only engineer and design your equipment to meet your requirements, but also build it.

Green engineering covers the range from 6 volts to 10,000 volts, from milliamperes to kiloamperes, using selenium metal plate rectifiers or tube rectifiers—as required.

Engineering and building rectifiers is Green's *only* business. We have nothing to sell but our interpretation of your individual needs.

*Illustration shows a remote control unit for 48 v. 2500 amp. installation.

"Rectifier Engineering is our Business"

SELENIUM • ARGON • MERCURY VAPOR • GRID CONTROL • HIGH VACUUM • XENON

W. GREEN ELECTRIC COMPANY, INC.

SELECTRO PLATERS AND ALL TYPES OF RECTIFIER EQUIPMENT

GREEN EXCHANGE BUILDING 130 CEDAR STREET NEW YORK 6, N.Y.

RECTIFIER G ENGINEERS

and corrosion, lower creep, more uniform crystal structure.

Known as the S-60 Universal hydraulic testing machine, this device is able to measure the following characteristics: Soundness of cable sheath welds, tensile stress, modulus of elasticity, elongation and ductility, compression, Brinell hardness, bending, sheer and uniformity. In addition to lead, many other materials used in cable manufacture can be tested, including metals, fabrics, plastics, paper and rubber-like materials.

Replacing at least three other types of equipment previously used, the new machine consists of an assembly that combines such important features as: (1) A deadweight load indicating system sensitive over an unusually wide range. (The operating range of the machine is from 120 lb. to 1200 lb., but tensile strength tests are regularly being made with satisfactory accuracy at as low as 5 lb.).

(2) Location of test specimens brought close for convenience of operation and ease of observation. (3) Several scale ranges possible by using different pendulum weights. (4) Smooth, hydraulic load applications with a wide variety of testing speeds.

The rate of movement can be varied from zero to 8¾ in. per min. under exact speed control, the length of stroke being 25 in. Slow rates are used for materials like lead, which have relatively high creep rates under tension. Faster speeds are used for fabrics, other metals, etc.

● Two new small plastic coaters have been designed by the *Youngstown Miller Co.*, Sandusky, Ohio for melting and maintaining ethyl cellulose and other plastic protective coatings in which parts and tools are dipped to prevent corrosion and mechanical injury. Each has a pump to provide a constant level in the dip tank, to remove surface film and bubbles. Thermostats control the electric heaters. One model melts 3 to 5 lb. of plastic per hr.; the other, 5 to 7 lb.

Rubber Cement for Bonding Metals, Etc.

A new rubber cement, named Plastilock 500, a non-thermoplastic, water and aromatic oil-resistant adhesive for bonding metals, wood, plastics and ceramic material to themselves or to each other, is announced by *B. F. Goodrich Co.*, Akron, Ohio. It provides superior bonding qualities, and in some cases can be used in place of rivets or screws.

In using it best results are gained by applying heat with pressure, although heating alone will give some degree of adhesion, the pressure providing good surface contact. The bond strength varies with the materials.

The new adhesive, used for metal-to-metal bonding has shown a shear strength of 3,250 p.s.i. Tension strengths of 4,000 p.s.i. have been reached. Tests made after the bonding of wood and plastic to aluminum, which presents extremely difficult problems of adhesion to other materials have resulted in the wood and plastic being torn because the strength of the bond was greater than that of these materials.

"Char-Mo" ..choice of the Specialist

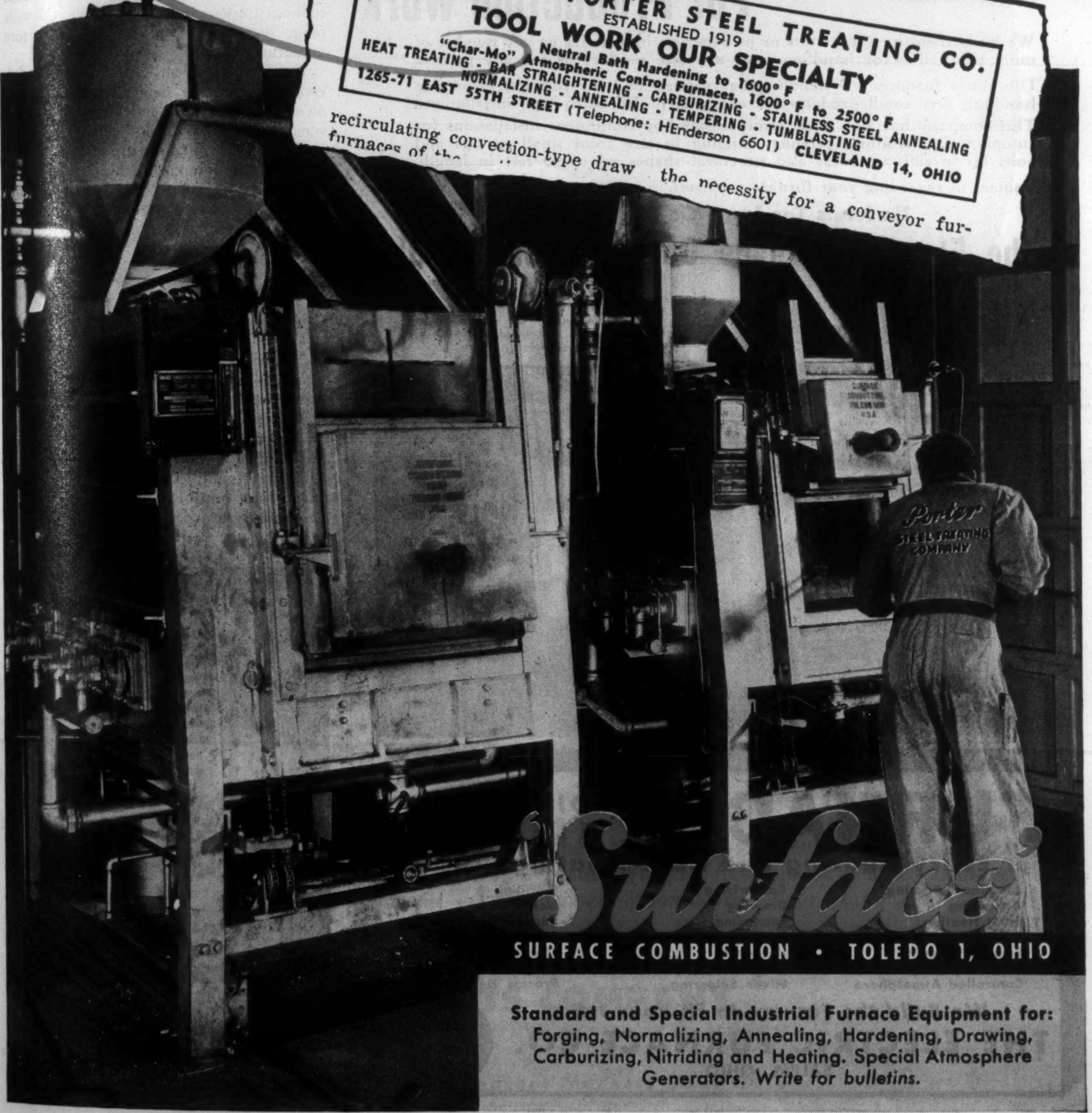
ANOTHER **large, modern, commercial heat treating plant, specializing in the hardening of high speed tool steels, after thorough investigation has selected Surface Combustion Char-Mo Furnaces.**

HUNDREDS **of other plants doing similar heat treating have also accepted Char-Mo Furnaces as the standard for the prevention of scaling and decarburization.**

Bulletin AG-43—"Design Features of Standard Rated Atmosphere Furnaces" includes complete description of Char-Mo Furnaces.

THE GEO. H. PORTER STEEL TREATING CO.
ESTABLISHED 1919
TOOL WORK OUR SPECIALTY
"Char-Mo" Neutral Bath Hardening to 1600° F
HEAT TREATING - BAR STRAIGHTENING - Atmospheric Control Furnaces, 1600° F to 2500° F
NORMALIZING - ANNEALING - CARBURIZING - STAINLESS STEEL ANNEALING
TEMPERING - TUMBLASTING
1265-71 EAST 55TH STREET (Telephone: HEnderson 6601) CLEVELAND 14, OHIO

recirculating convection-type draw the necessity for a conveyor fur-



SURFACE COMBUSTION • TOLEDO 1, OHIO

Standard and Special Industrial Furnace Equipment for: Forging, Normalizing, Annealing, Hardening, Drawing, Carburizing, Nitriding and Heating. Special Atmosphere Generators. ***Write for bulletins.***

An EF installation of gas-fired furnaces with quenches and gantry cranes for various annealing and heat treating cycles on large parts and products.

We build both continuous and

Batch Type Furnaces For Production Work

We build them in single units or in batteries; in any size or any number of units required — for handling most any size product or for any process.

The above furnaces for handling heavy parts and the furnaces below for handling very small products are examples of EF batch type installations.

This company has also made some outstanding continuous installations for automatically handling products ranging in size from small springs and bolts up to railway axles; also structural shapes up to 90 feet in length.

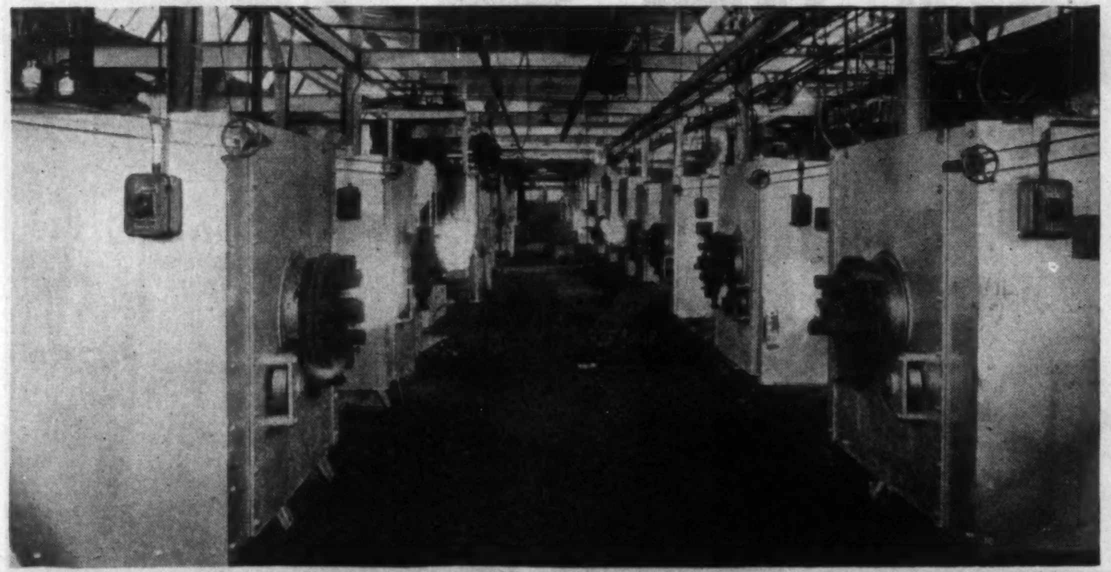
Contact us regarding *your* furnace problems.

No Job Is Too Large Or Too Unusual

The Electric Furnace Company, Salem, Ohio

Oil, Gas and
Electric Furnaces

Small parts such as gears, pinions, bolts, bearing parts and other products are carburized in EF rotary gas carburizers such as shown below. Sizes shown are handling 500 and 1000 lbs. per hour.



FURNACES OIL, GAS or ELECTRIC

For Every Heating and Heat Treating Process

Aluminum Brazing
Annealing
Billet Heating
Bright Annealing
Bright Hardening
Copper Brazing
Controlled Atmosphere
Carburizing
Drawing
Enameling
Forging
Hardening
Malleablizing
Silver Soldering
Nitriding
Normalizing
Soaking Pits
Scale-Free Hardening
Quenching Machines
Ceramic Kilns, etc.
Process Heating

We Build the Furnace to Fit Your Job

THE ELECTRIC FURNACE CO.

SALEM, OHIO

Electrode for Heavy Weldments

A new heavily covered arc-welding electrode for flat and horizontal fillet welding as well as for flat butt welding has been introduced by the electric welding division, *General Electric Co.*, Schenectady. Desirable wherever weld requirements include high mechanical properties, rigid X-ray examination, good profile, high deposition rate, and good surface appearance, the applications of this electrode include pressure vessels and pertinent connections, heavy machine bases, and structural parts, such as column plates, columns, roof trusses, beams, and girders where the thickness of the section permits.

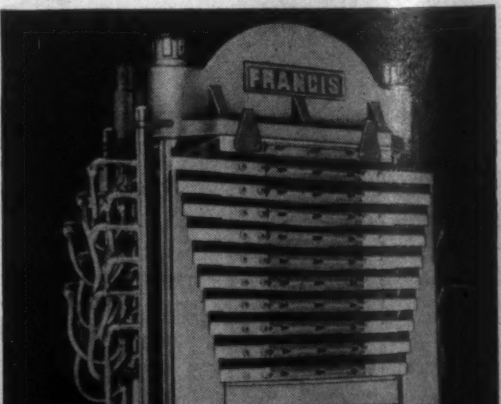
Known as Type W-27, the new electrode has an exceptionally high melting rate, resulting in increased production and higher speeds at the same current as other electrodes. At comparable production speeds, Type W-27 requires less heat input to the joint, thus reducing warpage and internal cooling stresses. It operates through a wide range of current, and has freedom from undercut.

Readily recognized by its steady, forceful, spray-type arc, the new electrode operates on a.c. or d.c. with either straight or reverse polarity. It has low spatter loss and easy slag removal, and produces welds of excellent appearance. It is available in three sizes: $^3/_{16}$ by 18 in., $^1/_4$ by 18 in., and $^5/_{16}$ by 18 in., and is rated A.W.S. classes E6020 and E6030.

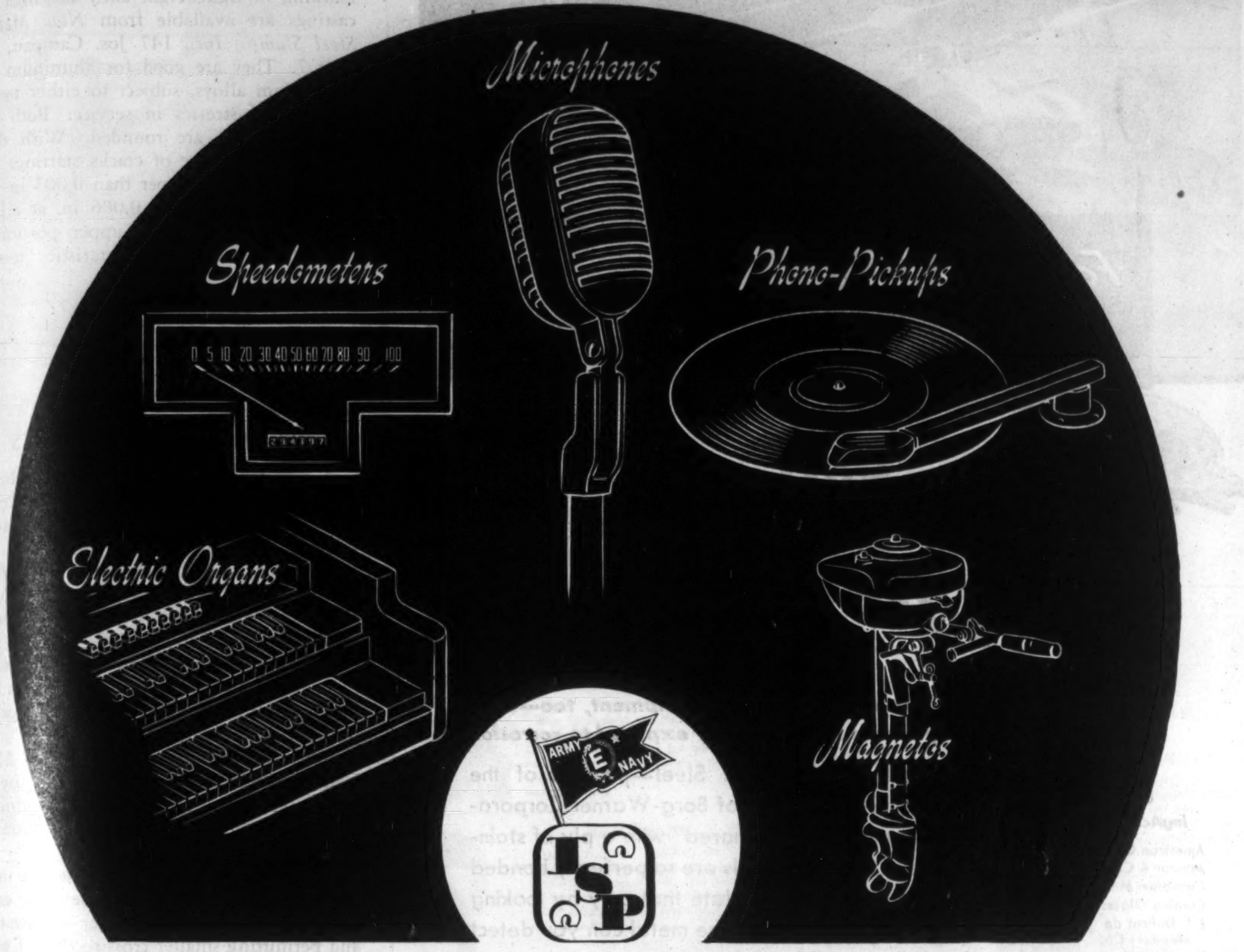
Steam Plate Hydraulic Press

A general purpose steam plate press, designed to handle laminated plastic for war items, but adaptable to peace time items such as plastic playing cards, is announced by the *Chas. E. Francis Co.*, Huntington, Ind. This 153-ton hydraulic press has motor driven pump, automatic pressure and temperature controls, and is equipped with 11 steam plates.

Among the features are a husky plate support, V's for easy loading, and a special locking device for strain rod nuts to prevent unscrewing. The press can be furnished with a 14- or 16-in. diam. cylinder and with or without the pumping unit.



PERMANENT MAGNETS MAY DO IT BETTER



(This is the first of four advertisements discussing the major functions of permanent magnets)

ELECTRIC CURRENT from MECHANICAL ENERGY through PERMANENT MAGNETS

The ability to create an electric current through the agency of a permanent magnet suggests to the engineer or product designer a wide range of useful applications.

Permanent magnets are able to transform mechanical into electrical energy in two ways—

1. *By producing a magnetic field through which an electrical conductor is moved mechanically—as in the case of generators, magnetos and velocity or dynamic microphones.*
2. *By acting as a polarizing agent, where reluctance to the magnetic circuit is varied by mechanical means; for example—the phonograph pick-up and inductor type magnetos and generators.*

This characteristic of the permanent magnet permits its use for the generation of electricity for actual power uses, or to produce devices for the control, detection and measurement of many materials.

Backed by 34 years of experience as the largest exclusive manufacturers of permanent magnets, our engineers will gladly consult with you on problems where the use of permanent magnets may do the job better. Write for free copy of technical booklet: "*Permanent Magnets Have Four Major Jobs*".

★ THE INDIANA STEEL PRODUCTS COMPANY ★
6 NORTH MICHIGAN AVENUE • CHICAGO 2, ILLINOIS

Specialists in Permanent Magnets Since 1910

COPYRIGHT 1945, THE INDIANA STEEL PRODUCTS COMPANY

For TANKS OR TURTLES

"Armored Protection" is VITAL!

That's true of your plant equipment, too—especially where steel is unduly exposed to corrosion.

IngAclad Stainless-Clad Steel—product of the Ingersoll Steel Division of Borg-Warner Corporation—is mild steel "armored" with a ply of stainless steel. The two metals are so perfectly bonded into a single sheet or plate that only by looking at the edge or back of the metal can you detect that it is not solid stainless.

In operation it gives real stainless service on the side that is used, yet costs much less than the solid metal. By specifying IngAclad Stainless-Clad Steel when you add new or rehabilitate old equipment you will effectively and economically armor your plant against corrosion.

Since we are producers of Ingersoll Solid Stainless and Heat-Resisting Steels as well as IngAclad Stainless-Clad Steel, Ingersoll Engineers are in a position to make unbiased recommendations.

Users of IngAclad Include:

American Cyanamid Co.
Armour & Co.
Carnation Milk Co.
Corning Glass Works
E. I. DuPont de Nemours Co.
Firestone Tire & Rubber Co.
Graver Tank & Mfg. Co.
Groen Mfg. Co.
Leader Iron Works
Monsanto Chemical Co.
Procter & Gamble Co.
Sherwin-Williams Co.
Solvay Process Co.
United States Potash Co.
Whiting Corp.
and many others.

INGERSOLL STEEL & DISC DIVISION
BORG-WARNER CORPORATION
310 South Michigan Avenue • Chicago 4, Illinois
Plants: Chicago, Ill.; New Castle, Ind.; Kalamazoo, Mich.

PRODUCTS OF BORG-WARNER

- Hard stamps with round face rather than sharp face characters for low stress marking of lightweight alloy forgings and castings are available from *New Method Steel Stamps, Inc.*, 147 Jos. Campau, Detroit 7. They are good for aluminum and magnesium alloys, subject to either tensile or torsional stresses in service. Both face and impression are rounded. With them there is less chance of cracks starting. Impressions are not deeper than 0.003 in. and fillets of not less than 0.006 in. at all intersecting surfaces. The upper portion of each shank bears a characteristic "temper color."

Metallic Arc Welding Process

A new type of automatic welding that is much simpler, faster and more economical than any known existing process of automatic arc welding is announced by the Lincoln Electric Co., Cleveland. It is designated for use with direct current, using a bare metallic electrode fed through a granular flux deposited on the joint.

Sufficient flux is applied to completely blanket the arc and molten metal. Unused flux is reclaimed for further use. It is called the "Lincolnweld."

Advantages of direct current are: More simplified and positive control; ability to weld non-ferrous metals; better control of electrode melting rate through option of straight or reverse polarity.

Extremely high current densities are used. Thus, a $\frac{1}{8}$-in. diam. electrode may carry 650 amp., producing greater penetration and permitting smaller cross section of weld metal, with cost saving and reduced warpage.

The process is less sensitive to scale and moisture than usual, reducing plate cleaning prior to welding. One type and grade of flux, with one analysis of electrode, can be used for a wide range of steel analysis. Thus, special joint preparations, changing of flux, wire analysis and welding procedure are eliminated. The equipment will take $\frac{1}{8}$ in. to $^{7}/_{32}$ in. electrode without changes of drive rolls, wire contacts or control.

The control is simple, with no vibrating relays or electronic devices. The electrode will feed in either direction. The standard head is changed from butt to fillet welding in a few minutes.

- A new reciprocating type semi-automatic high-speed plating machine with rotating cathode has been developed by *Lasalco, Inc.*, 2818 LaSalle St., St. Louis 10. Adopted recently by an aircraft plant, it utilizes man-hours more efficiently, maintains even quality of solution at the cathode, prevents corrosion of operating parts and plates inside surfaces of bearings and such parts, large and small. A single drive maintains both reciprocating action and chain travel, with chain and mechanism submerged in oil. The plating tank can be provided with agitator boot for single agitation, or combination of motions.

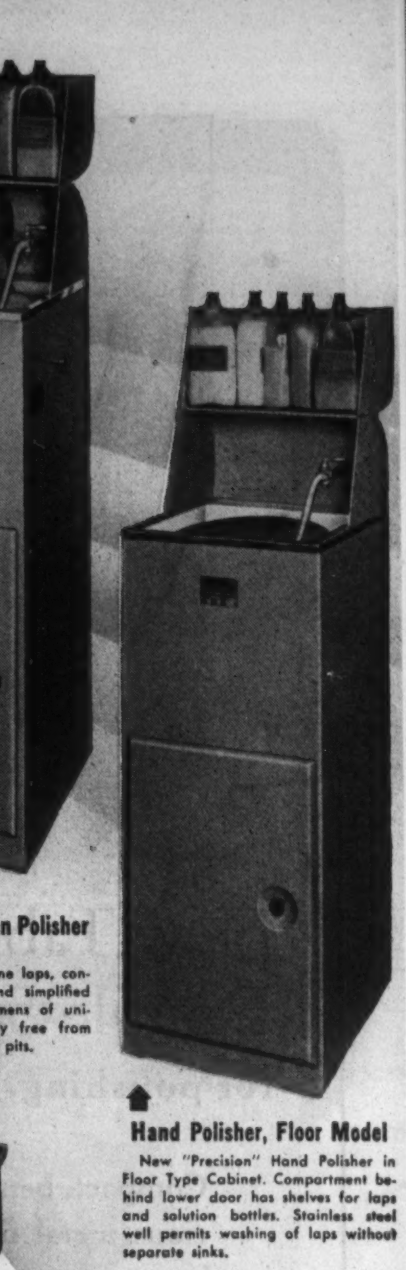
Air Operated Semi-Automatic Specimen Mounting Press
(Patent Pend.)
Radically new design. Eliminates hand operated hydraulic jack found in all other mounting presses. Does not require operator's continuous attention. Press is self-contained with built-in mold, time switch, thermostat, electric heaters and air pressure regulator.

Submerged Specimen Cutter
(Patent Pend.)
Only cutter in which specimens are fully submerged during cutting. Handles hard or soft materials. Wheel runs at slow speed; does not burn or damage specimen, ready to polish without grinding.

Automatic 6-Specimen Polisher
(Patented)
Specially prepared stone laps, continuous flow solutions and simplified technique produce specimens of uniform flatness, remarkably free from metal flow, scratches and pits.

Metallurgical Desk
(Patent Pend.)
New "Precision" Metallurgical Desk with Hand Polisher and Posture Chair. Cabinet provides space for laps and solutions. Convenient operating height allows space for operator's legs eliminating fatigue.

Hand Polisher
New "Precision" Polisher, for the small laboratory or large laboratory requiring a series of individual polishing machines. Utilizes advanced grind-polish principle in the Precision-Jarrett Automatic Polisher.



Hand Polisher, Floor Model
New "Precision" Hand Polisher in Floor Type Cabinet. Compartment behind lower door has shelves for laps and solution bottles. Stainless steel well permits washing of laps without separate sinks.

Simplified Specimen Preparation

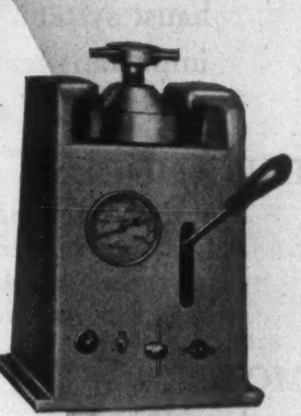
with "PRECISION ENGINEERED" Metallurgical Equipment

Advanced techniques utilizing the "Precision"-Jarrett simplified 3-step method of specimen preparations, speeds up production, improves the quality of the polished surface and greatly reduces preparation costs.

It is not an exaggeration to state that no other apparatus for preparing metallurgical specimens for microscopic examination has been developed to such a high degree of mechanical excellence or functional performance.

Whether your laboratory is large or small — research or control — there is a "Precision" metallurgical set-up to meet your exact needs and budget. Send for Bulletin 850-F.

See your laboratory supply dealer



Mounting Press
Not an adaptation of an ordinary hydraulic jack. Thermostatically controlled. Mechanical clocking device controls curing period. Specimens are molded and ejected hot.

Polishing Solutions
These solutions are supplied in five types for ferrous and non-ferrous metals. Simply dilute with 1 qt. of water and they are ready for use.

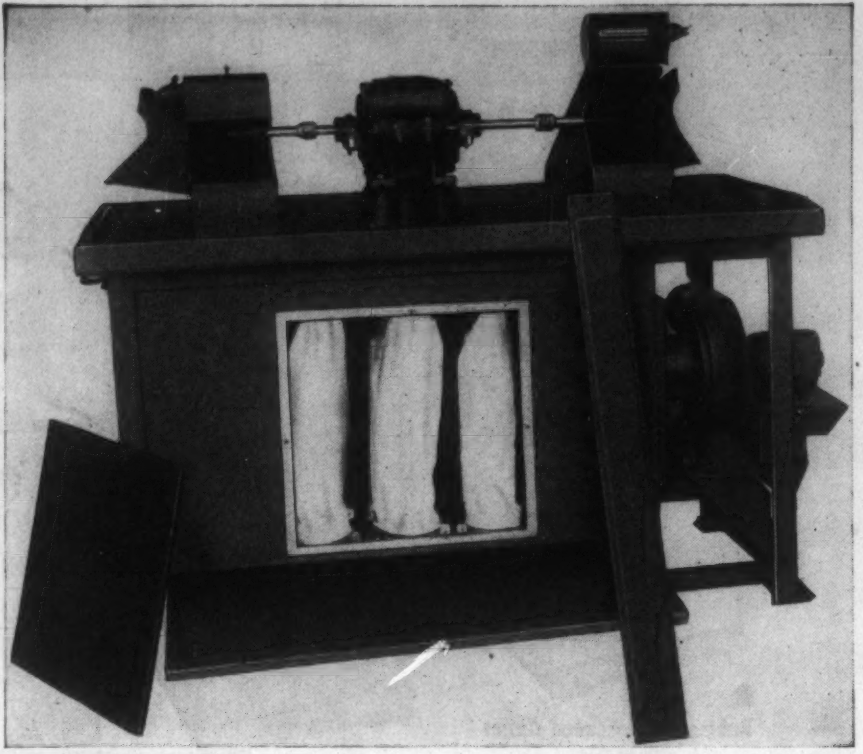
PRECISION-JARRETT
HARD BAKELITE POWDER
For mounting metallurgical specimens
PRECISION SCIENTIFIC CO.

Hard Bakelite Powder
For mounting specimens. Specially formulated to produce a hard mounting which adheres firmly to the specimen. Does not clog polishing laps.

Interchangeable Polishing Laps
Quick change laps are 12" diameter providing high and low speeds. Backings are aluminum, with stainless steel bushings. Laps are firmly cemented on backings. Cannot work loose, insures flat specimens.

PRECISION SCIENTIFIC COMPANY
1736-54 N. Springfield Ave., Chicago 47, U.S.A.

★ *Engineers and Builders of Scientific Apparatus and* ★
Production Control Laboratory Equipment for Almost a Quarter Century



New Table Model Double-Spindle Polishing Lathe

for polishing, buffing, lapping Precious Metals

Compact, bench-type polishing lathe used in the precious metal field. Self-contained separator and exhaust system. 62 in. long, 26 in. wide. Among the important features of this sturdily built lathe are the dust hoods and dust containers described below.

DUST HOODS

Movable side door in hood permits polishing of larger objects. Adjustable hinged cover may be raised or lowered according to diameter of wheel. Hood covers have light sockets, with ON-OFF switch for illumination of work—shaded for eyes of operator.

MOTOR

Double spindle, variable speed with maximum of 3500 R.P.M.

DUST CONTAINER

Cloth, tubular system encased in galvanized sheet metal chamber, housed beneath table. Shaking apparatus dislodges clinging particles from walls of cloth tubes into removable dust pan in bottom of chamber.

BLOWER

High suction type, motor driven, cushioned on assembly frame by rubber pads.

Our Engineering Department will be glad to consult with you and help in solving problems concerning Electroplating Equipment. No obligation involved for interviews. Write or 'phone.

MUNNING & MUNNING, Inc.

Engineers and Manufacturers — Electroplating Equipment and Supplies

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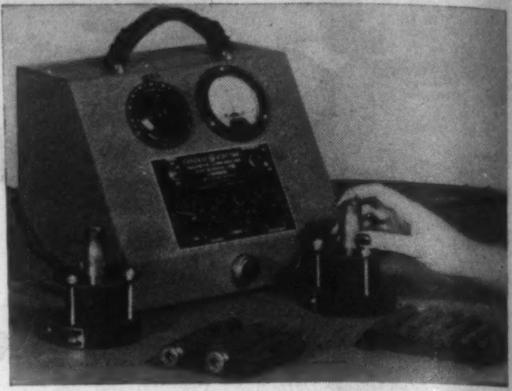
Magnetic Comparator

A magnetic comparator for inspecting ferrous parts such as testing rods, bolts, springs and small fabricated parts, discerning variation in composition, hardness or other qualities that effect magnetic properties, has been redesigned by *General Electric Co.*, Schenectady.



Graduated dial plates on the sensitivity and balance control rheostats have been added to allow duplication of settings. Also, a light now indicates whether power is on. Receptacles for making connections to the test fixtures and power source are now at the back of the case, thus keeping wires out of the operator's way and allowing a clear view of the indicating instrument.

The circuit is balanced by placing an acceptable part of each of the two test fixtures. One of these parts is then removed and those to be tested are individually inserted. Any deflection of the pointer indicates a deviation from standard in magnetic characteristics.

Adjustable Precision Counterbores

Counterbores of a new and unique design adjustable to 0.001 in. over a range of 1/32 in. are now being marketed by *Precision Mechanical Laboratory*, 119 W. 63rd St., New York 23. They can be run either right or left hand.

The bit can be reset after many grindings to the desired recess size, retaining extreme tolerances on both standard and non-standard diameters. Small machine screw head diameters are easily accomplished.

The high-speed steel bit gives a smooth, chatter-free cut. The single bit design affords unusual chip clearance. Deep recesses in laminates, plastics and softer metals are cut at high speeds without withdrawing the tool. Only the end of the bit need be reground on a bench grinder, eliminating tool room grinding and skilled labor. Any contour can be ground on the bit end. The bit can be removed from the holder while on the machine.

These counterbores with desired pilots are available from 1/4 to 1 in. with either straight or tapered interchangeable shanks. High-speed steel bits are standard, but carbide and alloy bits are available.

Make 6-Ways Better Welds with EUTECTIC

(Pronounced U-TEC-TIC) Reg. U. S. Pat. Off.

Low Temperature WELDING RODS

EUTECTIC welds are: SMOOTHER • STRONGER • BETTER COLOR MATCHED • MORE MACHINABLE • FASTER TO MAKE and REQUIRE LESS HEAT, avoiding distortion, stresses and overheating

No other welding or brazing process affords welders such a combination of advantages at such low bonding temperatures (as low as 340° F) and little heat consumption.

EUTECTIC *Low Temperature* Welding, the most revolutionary welding development of modern times, enables you to weld joints at temperatures *below the fusion points of base metals*—eliminating the many hazards of high temperature fusion welding.

All metals can be joined by the EUTECTIC process. No special skill is required . . . no extensive training needed. All standard methods of heating are employed: Gas—Arc—Furnace and others in combination with the new EUTECTIC Welding Rods and Fluxes.

If you have Oxy-Acetylene or Arc welding equipment all you need is an assortment of Eutectic Rods in order to add this important improvement to your equipment. Get the facts today! Fill in the coupon at once for full information.

Castolin Eutectic

EUTECTIC WELDING ALLOYS COMPANY

Originators of Eutectic *Low Temperature* Welding

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Please send me full information for purchasing an introductory assortment of important Eutecrods for Production . . . Salvage and Maintenance welding.

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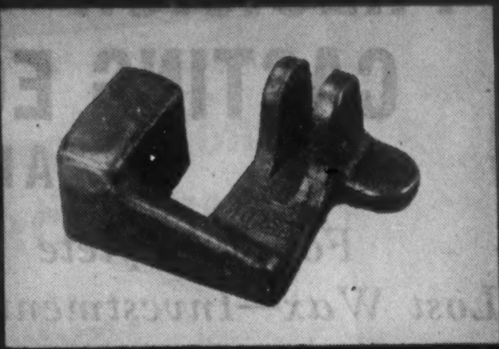
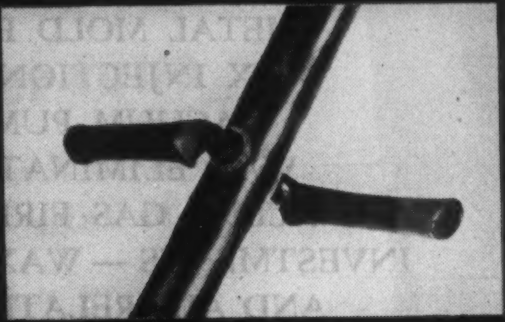
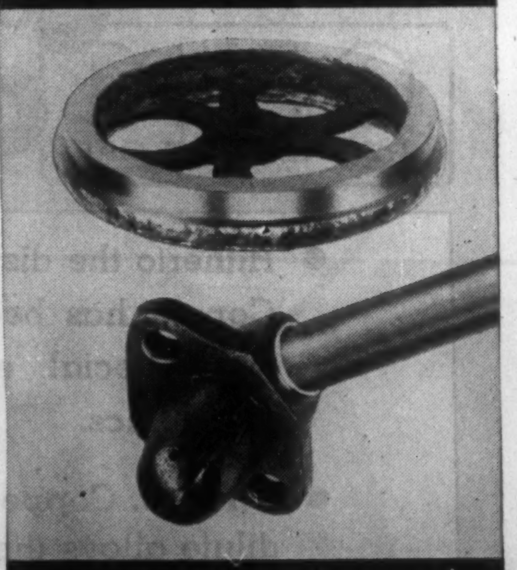


EXTRA SMOOTHNESS is demonstrated in this Cast Iron lug built up with EutecRod 14.



UNUSUAL STRENGTH is proved by twist test of Chrome Moly steel tube welded with EutecRod 16.

PERFECT COLOR MATCH of the weld was obtained in this Bronze casting built up with EutecRod 18.



(Above) EASY MACHINING to a smooth finish is demonstrated on this Cast Iron wheel resurfaced with BRONZOCHROM rod 185.

(Below) COPPER TUBE and bronze fitting welded with EutecRod 1800 required no after machining because of smooth fillet formed.

PRECISION CASTING EQUIPMENT AND SUPPLIES

For Complete Installations
Lost Wax—Investment Molding Process

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CENTRIFUGAL CASTING MACHINES
METAL MOLD EQUIPMENT
WAX INJECTION MACHINES
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OXYGEN FREE HIGH CONDUCTIVITY COPPER

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- **Hitherto the distribution of O.F.H.C. Copper has been restricted to certain special end uses such as electronics.**
- **O.F.H.C. Copper and a few special dilute alloys thereof are now available for most uses.**

THE AMERICAN METAL COMPANY, LTD.
61 Broadway, New York, N. Y.

Master Gage Sets

A new set of gage blocks makes possible the widest range of combinations of any gage set on the market, it is claimed by *Continental Machines, Inc.*, Minneapolis 4. Called DoAll gage set No. 118, it is designed for the gage department that requires a complete set of gage blocks. It is a master series.

The makers point out five features: (1) It is well represented by so-called thin blocks, ranging from 0.010 in. to 0.90 in., and embracing three series. (2) It is well represented by standard gage sizes. (3) Because our measuring systems are based on fractions, a series of three fractional size gages, combined with six of the standard blocks makes possible a combination of every fraction in steps of 1/64 in. from 1/32 in. to 2-47/64 in., inclusive. (4) Standard sets are in steps having a minimum increment of one ten-thousandth in. (5) Special or "wear" blocks protect the regular gages where used under excessive wear conditions. There are two tungsten carbide wear blocks of 0.050 in.

Each individual block is stabilized by six cycles of annealing and freezing to minus 120 F., hence will not change more than a few millionths of an inch over many years. The 118-piece set is available in three grades of accuracy: laboratory, general inspection and working set. They have a hardness of Rockwell C-65. Gaging surface is flat to the very edges.

● A new protective coating for the sidewalls of both wet and dry spray booths is announced by *Detrex Corp.*, 13005 Hillview Ave., Detroit 27. Called "Triad PR," it provides for the booth to be stripped clean simply by spraying with water or steam. The Triad PR and accumulated paint flush off together. It can be applied by either brush or spray gun, and dries to a hard, white dustless coating that improves visibility in the booth.

Plants and Slants

Showmanship, often a novelty to industry, was used successfully to ferret out additional thousands of urgently needed war workers in a tight labor area. The *Western Cartridge Co.*, Div. of *Olin Industries, Inc.*, East Alton, Ill., arranged a "Get One Now" drive, patterned on the Hollywood talent scout idea. Regular workers brought in new employees and were awarded medals and a dinner "on the house." Also effective was a whirlwind road show that played five stands a week for five weeks in 25 towns in a 50-mile hiring area. Included in the show were four returned war heroes, three Army films, and an exhibit of small arms and ammunition. After each show new workers were signed up. Advertising was used in newspapers and elsewhere. Results were "terrific."

Greater acceptance and increased production of ZIRMET (FOOTE DUCTILE ZIRCONIUM) for gettering (purity 99.9% +) permits . . .

50% PRICE REDUCTION

Now costs only 2¢ to 3¢ per tube

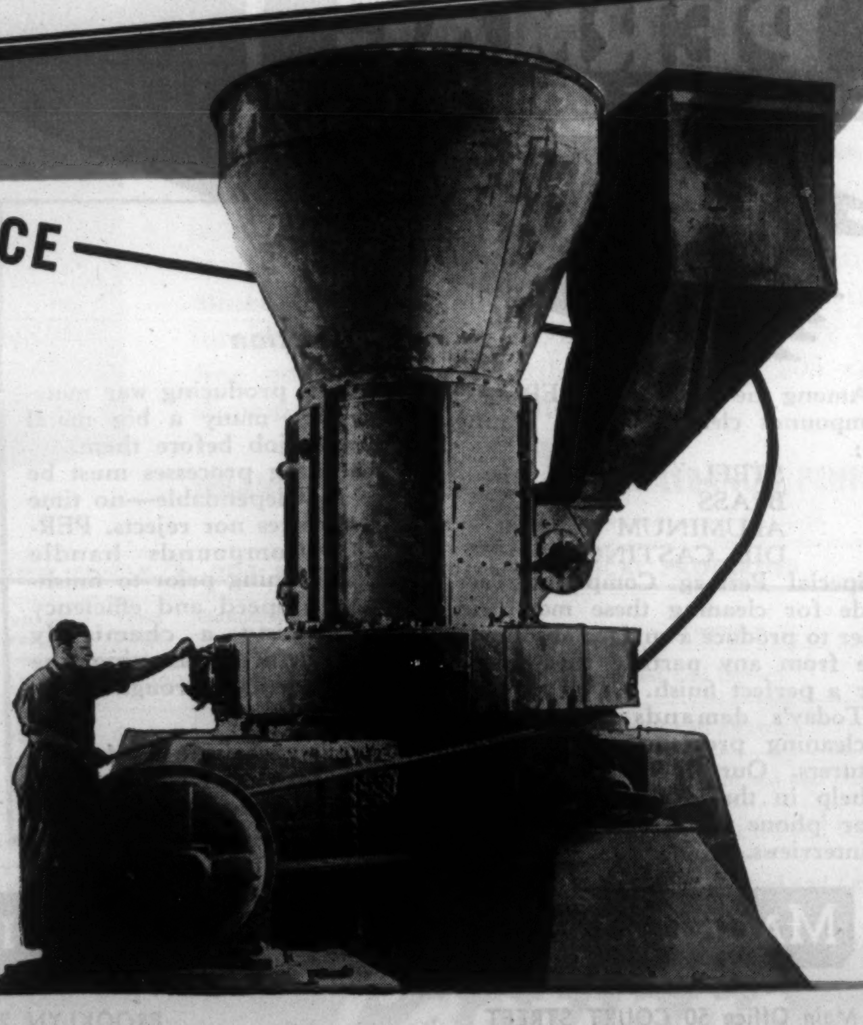
Need approximately but one-eighth square inch of .003″ or .005″ sheet for a continuous getter in usual sizes of tubes.

- Ductile Zirconium can be used in all types of tubes, including mercury vapor rectifiers.
- Readily spot welded to tantalum, molybdenum, nickel, etc.
- Corrosion resistant.
- Ease-of-use effects savings in production costs.
- Non volatile (produces clear tubes)
- Best temperature: 400°C. or over.

ZIRMET (FOOTE DUCTILE ZIRCONIUM) IS NOW AVAILABLE IN PRODUCTION QUANTITIES OF SHEET, WIRE OR ROD

Write immediately for details and quotation.

WHERE SIZE IS A SCIENCE



This is one of many types of mills used by Foote for producing from ores and minerals the grindings and granulations consumed by industry. The all-important control of particle size through grinding, and the processes related to grinding such as tabling, calcining, drying and magnetic separation are reduced to a science at Foote's three plants.

Foote
MINERAL COMPANY
A Step Ahead in Industrial Ores and Chemicals

PHILADELPHIA • ASBESTOS • EXTON, PENNSYLVANIA
Home Office: 1608 SUMMER STREET, PHILADELPHIA 3, PA.
West Coast Repr.: Griffin Chemical Co., San Francisco, Calif. • English Repr.: Ernst B. Westman, Ltd., London, Eng.

HOW THE WROUGHT BRASS INDUSTRY CONSERVES METAL

No industry melting *commensurate tonnage** of vital metal can quite match the brass mills for conservation and low melting losses. The savings of metal total millions of pounds; clearly the method they use is worth noting:

Virtually all the brass mills in North America use the Ajax-Wyatt induction melting furnace, for it has the lowest metal losses in the field — less than 1% — with superior temperature control and unapproached economy of operation on high production schedules such as we have today.

Do you have your copy of "AJAX-METELECTRIC PROGRESS," the news magazine of induction melting, electric heat treating, non-ferrous ingot and alloys? Write to: AJAX ELECTRIC FURNACE CORP., 1108 Frankford Avenue, Philadelphia 23, Pa.

* UPWARDS OF 5 BILLION POUNDS ANNUALLY

THE AJAX WYATT INDUCTION MELTING FURNACE

ASSOCIATE COMPANIES:
AJAX METAL COMPANY, *Non-Ferrous Ingot Metals and Alloys for Foundry Use*
AJAX ELECTROTHERMIC CORPORATION, *Ajax-Northrup High Frequency Induction Furnaces*
AJAX ELECTRIC COMPANY, INC., *The Ajax-Hultgren Electric Salt Bath Furnace*
AJAX ENGINEERING CORPORATION, *Ajax-Tama-Wyatt Aluminum Melting Induction Furnaces*

PERMAG CLEANING COMPOUNDS

Promote Faster Production

Plants producing war material have many a big metal cleaning job before them.

Cleaning processes must be fast and dependable—no time for mistakes nor rejects. PERMAG Compounds handle metal cleaning prior to finishing with speed and efficiency—producing a chemically clean surface—hastening the finished article through to its destination.

Metal fabricators depend on PERMAG Compounds for cleaning operations.

Among the metals that PERMAG Compounds clean prior to plating are:
STEEL
BRASS
ALUMINUM
DIE CASTINGS

Special Permag Compounds are made for cleaning these metals in order to produce a surface absolutely free from any particle that would mar a perfect finish.

Today's demands bring hard cleaning problems to manufacturers. Our Cooperative Service help in these difficulties. Write or 'phone us. No obligation for interviews.

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Nationally represented Warehouses in principal cities
In Canada, Canadian PERMAG Products Ltd., Montreal and Toronto

"Angels on wheels!" That's what they call 30 small and agile women who operate the cranes in the two plants of *Babcock & Wilcox* at Alliance, Ohio. They spend working hours in small control rooms on wheels 35 ft. above the floor. Accidents and crane labor turnover are at a minimum. "Angels" often cover 100 miles per week. Operators pass a strenuous physical examination and must have 20-20 vision. She must have "pre-flight" training of 80 hours "in the air." Men workers on the floor frequently remark: "She's as good as a man."

Ceremonies involving receipt of the fourth Army-Navy "E" by the *Brown Instrument Co.,* Philadelphia, received a new twist when a group of discharged service veterans, all former employees, were at the receiving end of the award. The general manager says: "We selected these men because we felt they represented both the fighting men in our armed services and the workers on the home front."

Monsanto Chemical Co. manufactures the launching propellent chemical for American robot bombs and the rocket motors used in launching. A carriage, into which a cluster of rocket motors is fitted, leaves the ramp along with the bomb. After the bomb is a safe distance from the ramp, the carriage and rocket motors fall to earth.

The highest leaching plant in the world, clinging to the barren Andes mountains in Peru, three miles above sea level, has been completed by the *Rust Engineering Co.,* Pittsburgh, for *Vanadium Corp. of America* to speed production of vanadium. The various structures stand higher than the tallest mount in the U. S. (Mt. Whitney, 14,495 ft.).

Eagle-Picher has acquired the production and distribution facilities of the *Southern Lead Co.,* Dallas, Texas. Operations will be conducted under the newly created firm name, *Eagle-Picher Co. of Texas.* This deal broadens their activities to include die casting. Considerable new fabricating machinery will be added.

Production suggestions helping the war production program netted *General Electric* workers $232,735 in awards in 1944. Payment was for 19,488 ideas. The highest single award, $2,000, went to Orvar N. Ericson, G. E. toolmaker for 22 years, for an idea pertaining to a new remote fire control system on the Superfortress. It is believed the largest award ever given by any manufacturing plant in the country, and is in harmony with the company's nickname, "Generous Electric." Since the award plan started in 1906, G. E. has paid out $1,500,000.

An organization of inventors, engineers, research men and market analysts, called *Associated Engineering & Research Companies,* has established offices at 150 Broadway, New York. They are ready to serve manufacturers seeking needed new products in the electro-mechanical field. Robert Wallach is executive director.

Engineers long associated with Henry J. Kaiser and responsible for the design and construction of some of the world's out-

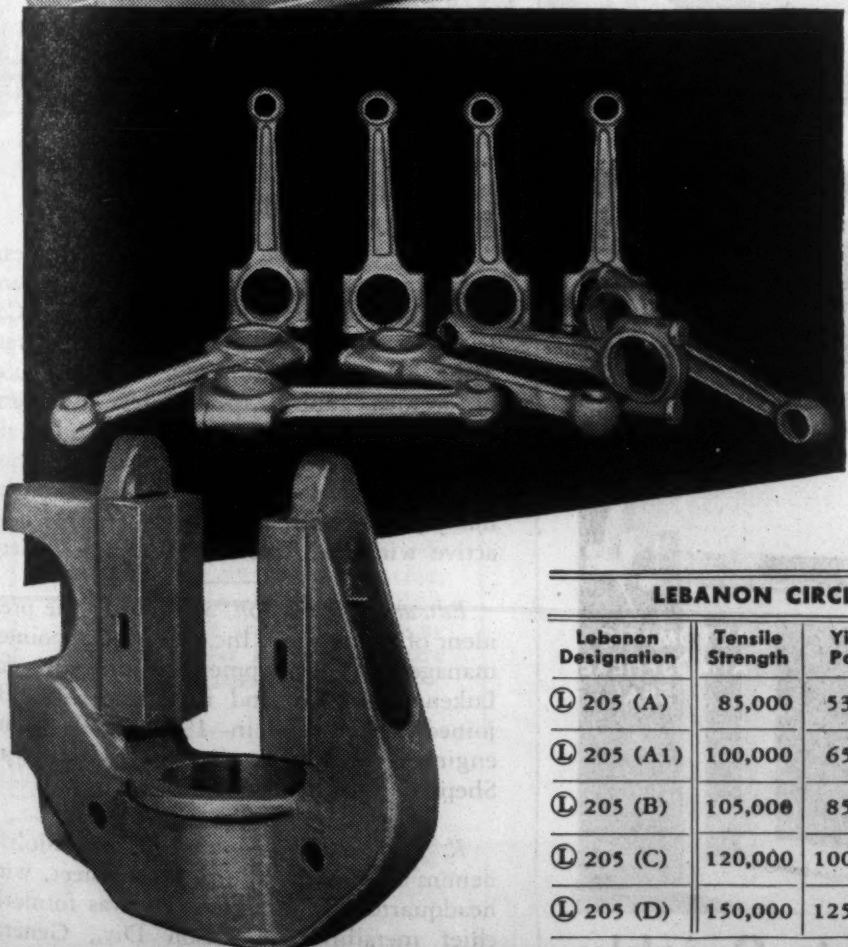
Meet Wide Range of Design Requirements With Lebanon Ⓛ 205

MODERN engineering design of castings often calls for a material that combines structural versatility and economy with a broad range of physical properties. After extensive study, Lebanon Steel Foundry developed such a material in Circle Ⓛ 205—a Nickel . . . Chromium . . . Molybdenum alloy.

Outstanding characteristic of Lebanon Circle Ⓛ 205 is its adaptability to wide modification of physical properties through heat treatment. It can, in many instances, be used as an alternate for materials of higher alloy content and, where it is so used, WPB approval may be facilitated.

One important application of Circle Ⓛ 205 is its low temperature properties.

The broad possibilities of Circle Ⓛ 205 make it worth considering wherever service conditions indicate low alloy steel castings. The type of heat treatment suited to requirements is best determined through consultation with Lebanon metallurgists and foundry engineers. Write today for free new bulletin describing Circle Ⓛ 205 and showing typical applications.



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ORIGINAL AMERICAN LICENSEE GEORGE FISCHER (SWISS CHAMOTTE) METHOD

LEBANON CIRCLE Ⓛ 205 SPECIFIED MINIMUM PHYSICAL PROPERTIES

Lebanon Designation	Tensile Strength	Yield Point	Elongation in 2"—%	Reduction of Area—%	B. H. Average	Heat Treatment
Ⓛ 205 (A)	85,000	53,000	22	35	185	Normalized and Drawn
Ⓛ 205 (A1)	100,000	65,000	17	30	210	Normalized and Drawn
Ⓛ 205 (B)	105,000	85,000	15	30	220	Normalized, Quenched and Drawn
Ⓛ 205 (C)	120,000	100,000	12	25	260	Normalized, Quenched and Drawn
Ⓛ 205 (D)	150,000	125,000	10	20	320	Normalized, Quenched and Drawn

Lebanon ALLOY AND STEEL *Castings*

TIME AND MONEY ARE S-A-V-E-D WHEN KELLOGG CASTABLES ARE ON HAND

Users of Kellogg Castables—KASTIC and KEL-CRETE reduce furnace shut downs by making their own special shapes, jambs, door linings, baffle walls, ducts, dampers, car tops, etc. by simply adding water to the scientifically prepared Kellogg mixture. No waiting for delivery of special shapes from a distant point.

KELLOGG KASTIC MW KELLOGG
KELLOGG KEL-CRETE MW KELLOGG
M KELLOGG W

KASTIC...

KASTIC prepared in two grades—Industrial and Domestic; both with a maximum working temperature of 2600°F.

KEL-CRETE...

KEL-CRETE is light in weight—60-65 pounds per cubic foot with a maximum working temperature of 2000°F.

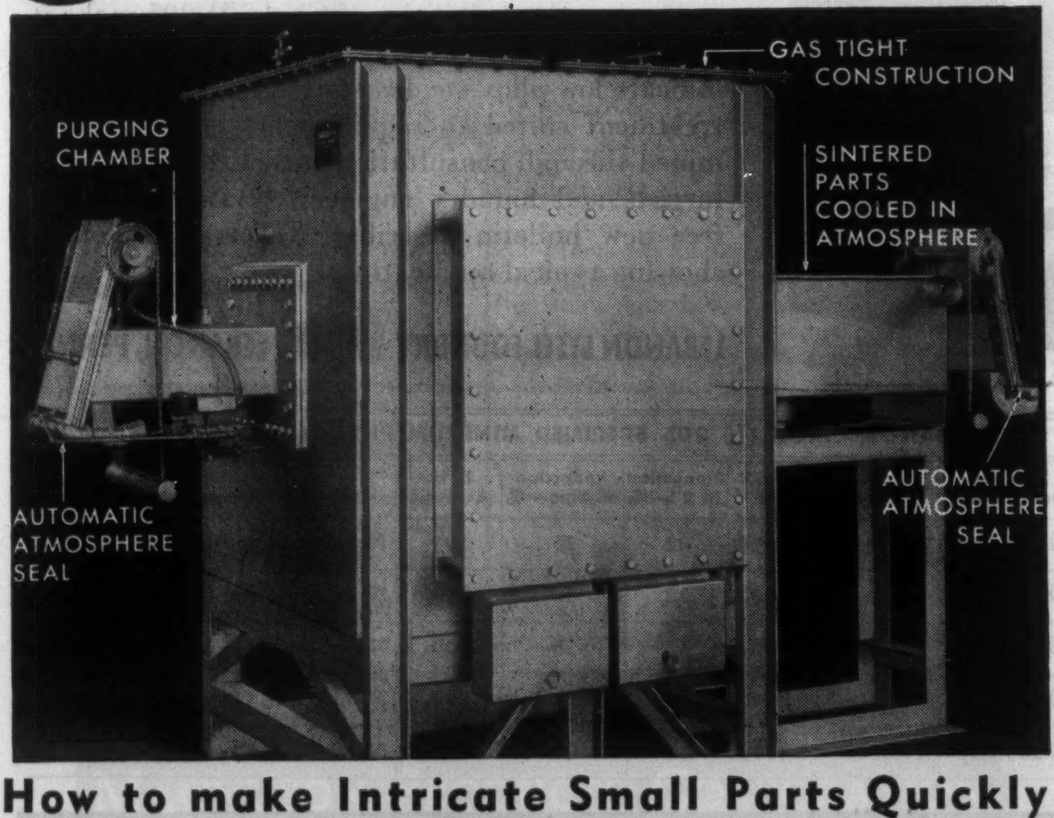
Write today for bulletins giving information on these products.

THE M. W. KELLOGG COMPANY

Sales Office: 225 Broadway, New York 7, N. Y. *Plant: Jersey City, N. J.*

Representatives in CHICAGO • DETROIT • PITTSBURGH • LOS ANGELES

Harper FURNACE FOR POWDERED METALS


GAS TIGHT CONSTRUCTION
PURGING CHAMBER
SINTERED PARTS COOLED IN ATMOSPHERE
AUTOMATIC ATMOSPHERE SEAL
AUTOMATIC ATMOSPHERE SEAL

How to make Intricate Small Parts Quickly

Manufacturers are short-cutting production of intricate parts by sintering powdered metals in Harper continuous process furnaces. Harper design results in uniform quality of your product. Write for data.

HARPER
ELECTRIC FURNACE CORP.
1461 Buffalo Ave., Niagara Falls, N. Y.

standing projects, have organized as a permanent group, *"Kaiser Engineers,"* Kaiser Bldg., Oakland, Calif. The policy of the new company is to undertake engineering work in any part of the world. They are experienced in all major fields of engineering. The president of the new organization is, of course, Henry J. Kaiser.

The Carbondale plant of the *American Welding Co.,* wholly-owned subsidiary of *American Car & Foundry Co.,* is to be closed April 30, 1945, with all equipment disposed of and the plant itself offered for sale. The plant was originally built to produce forge-welded tank car tanks, forge-welded containers and Morison furnaces, etc.

The *Indar Corp.,* 330-332 Lemcke Bldg., Indianapolis, offers a new kind of metallurgical service, supplying a complete line of all available metals for scientific, experimental or production purposes. The metals can be supplied in wrought, powder or lump form. The company will also compound fluxes of special compositions for every important application.

Production has started in a new cleaning compound manufacturing plant of the *Homestead Valve Mfg. Co.* at Edgeworth, Pa. The compound is for steam spray cleaning machines.

Scott Testers, Inc. is the new firm name of *Henry L. Scott Co.,* Providence, R. I., makers of testing machines. The change is one of name only and better describes the firm in relation to the equipment it manufactures.

News of Engineers

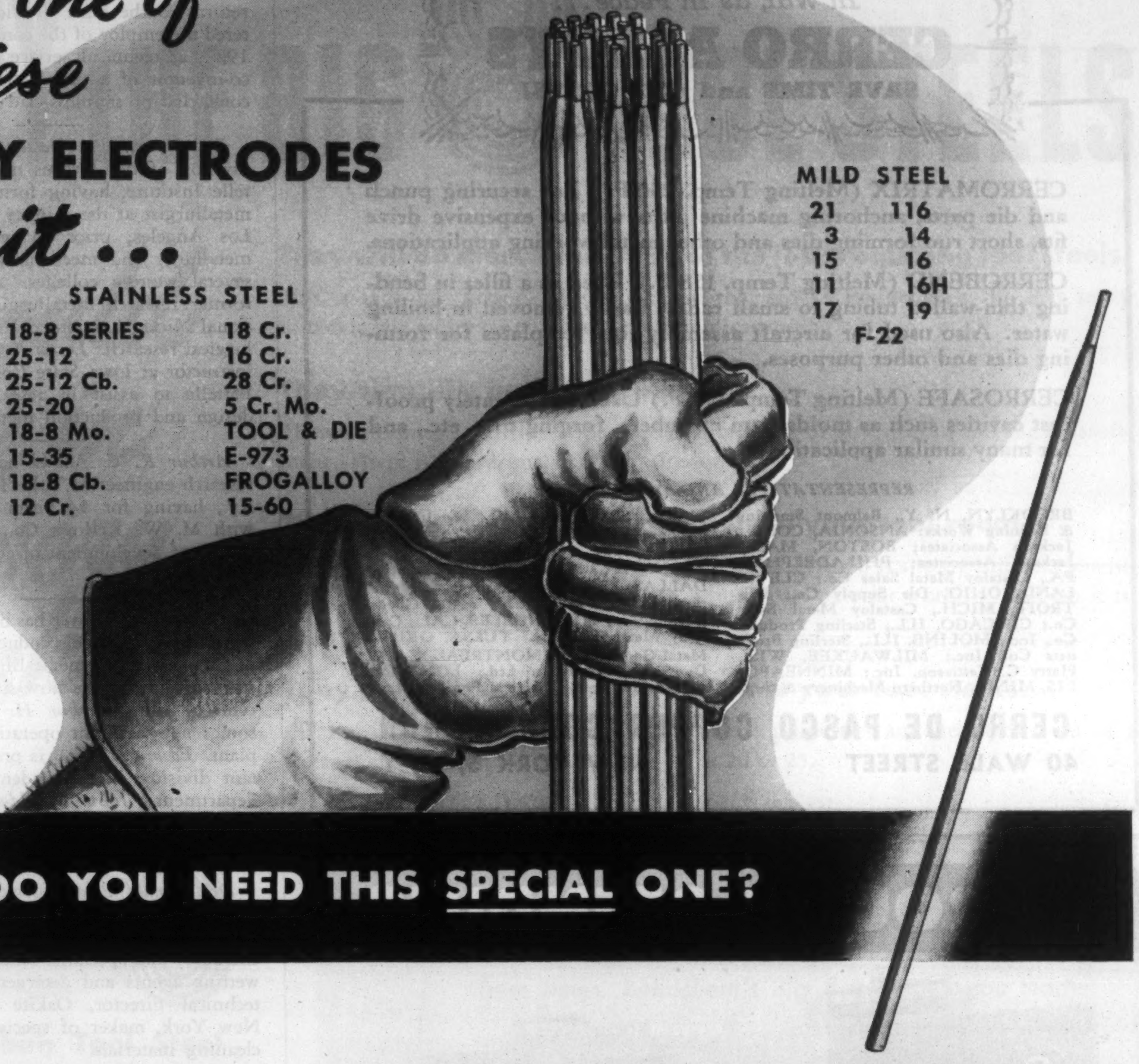
Frank G. Flocke, for the past 15 years with the technical service, development and research division, International Nickel Co., has been made general manager of the Trent Tube Mfg. Co., East Troy, Wis., producer of welded tubing in stainless steel and nickel alloys. He has been active in all-welded tank cars of nickel-clad steel and other clad steel projects. He has authored many papers on these subjects, and has been active with the American Welding Society.

Edward J. Charlton, assistant to the president of Lukenweld, Inc., has been appointed manager of development engineering for Lukens Steel Co. and its subsidiaries. He joined Lukenweld in 1931 as designing engineer, and in earlier years was with Shepard Niles Crane & Hoist Co.

R. L. Heath has joined Climax Molybdenum Co. as metallurgical engineer, with headquarters at St. Louis. He was formerly chief metallurgist, Allison Div., General Motors Corp. at Indianapolis, where he served on several S.A.E. committees dealing with aircraft engine materials and packaging.

Frederick P. Huston has been placed in charge of railroad developments in application of nickel alloy steels, cast irons, Monel

Does one of these McKAY ELECTRODES *suit . . .*



STAINLESS STEEL	
18-8 SERIES	18 Cr.
25-12	16 Cr.
25-12 Cb.	28 Cr.
25-20	5 Cr. Mo.
18-8 Mo.	TOOL & DIE
15-35	E-973
18-8 Cb.	FROGALLOY
12 Cr.	15-60

MILD STEEL	
21	116
3	14
15	16
11	16H
17	19
	F-22

OR DO YOU NEED THIS SPECIAL ONE?

McKAY GIVES YOU THE RESEARCHED LINE

The McKay slogan, "*every* electrode a leader," is based on the determination to make every grade as good as painstaking research, careful manufacturing and unusually thorough step-by-step testing can make it. In addition to our own laboratories, an active fellowship in Mellon Institute fully qualifies McKay Electrodes to be called the *Researched Line.*

You will find in the *standard* line of McKAY Electrodes an exceptionally wide range of mild steel, alloy steel and stainless steel rods of analyses suited to almost every welding need. From a range of 40-odd mild, alloy and stainless grades, you can normally select an electrode which will exactly fit your requirements.

Occasionally, however, the need for a special electrode for a specific purpose will arise. In such cases, the facilities of our plant laboratory, working in collaboration with our Mellon Institute research department, will be placed at your service to develop the proper type of electrode for your particular job.

If available standard selections are not adequate, don't hesitate to ask for *this special* McKay service. Send full technical facts for our recommendations.

GENERAL SALES OFFICES: YORK, PA.

THE McKAY COMPANY
PITTSBURGH, PA.

WELDING ELECTRODES . . . COMMERCIAL CHAINS . . . TIRE CHAINS

In War, as in Peace...

CERRO ALLOYS

SAVE TIME and CUT COSTS!

CERROMATRIX (Melting Temp. 250°F.) For securing punch and die parts, anchoring machine parts without expensive drive fits, short run forming dies and other metal-working applications.

CERROBEND (Melting Temp. 158°F.) Used as a filler in bending thin-walled tubing to small radii. Easily removed in boiling water. Also used for aircraft assembly jigs, templates for forming dies and other purposes.

CERROSAFE (Melting Temp. 190°F.) Used to accurately proof-cast cavities such as molds, gun chambers, forging dies, etc., and for many similar applications.

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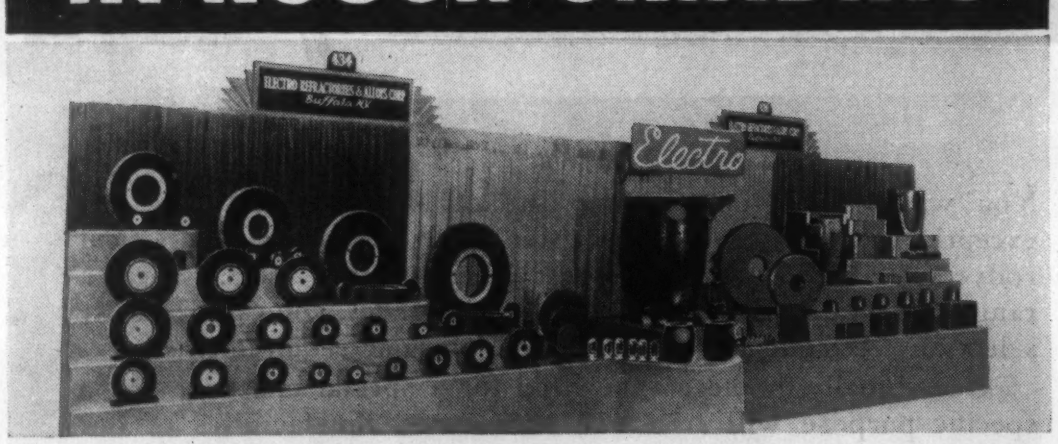

...it's not Cost of Wheel that counts,

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and other nickel alloys at the International Nickel Co., Inc. He has been associated with the Inco Mill Products Div., but now returns to the same division where he entered the employ of the company in October, 1927, as technical service engineer. He is co-inventor of a process for producing Inconel-clad or stainless-clad plate.

Dr. Herluf P. Nielsen has joined the division of non-ferrous metallurgy of Battelle Institute, having formerly been chief metallurgist at the Kinney Aluminum Co., Los Angeles, prior to which he taught metallurgy and mechanical engineering at several western colleges. *Albert M. Hall,* former research metallurgist with International Nickel has joined Battelle for metallurgical research. *Lester F. Clawson,* former instructor at Iowa State College, has joined Battelle to assist in research on product design and production methods.

Arthur R. C. Markl has become chief research engineer of Tube Turns, Louisville, Ky., having for 14 years been associated with M. W. Kellogg Co., New York, in charge of development of equipment for oil refineries.

Raymond D. Dwyer has been made superintendent of the steel production department of Gary works, Carnegie-Illinois Steel Corp. *Jacob C. Wilkins* is now superintendent of central mills. *Arthur H. Hjortsberg* becomes new assistant operating head of the plant. *Edwin H. Gott* is promoted to assistant division superintendent, in charge of departments. *John J. Golden* becomes division superintendent of the combined open hearths and central mills.

Dr. Donald Price, formerly with Interchemical Corp. and National Oil Products Co., author of technical papers on organic chemistry and specialist on sulphonated oils, wetting agents and detergents, has become technical director, Oakite Products, Inc., New York, maker of specialized industrial cleaning materials.

Howard A. Sommers has been made chief engineer of the Mathieson Alkali Works. Among his varied activities has been design and construction of magnesium plants.

Howard A. Byrns has been made chairman of the blast furnace, open hearth and coke committees of the American Steel & Wire Co., while *Harold Cope* is now general superintendent of central furnaces and coke works in Cleveland.

Leonard G. Renouf, on the laboratory staff of Titanium Alloy Mfg. Co., Niagara Falls, N. Y., for eight years, has been made superintendent of refractory production. *A. R. Fowler* is now chemical engineer. *Sarkis Saryan* has become analytical chemist. *Ernest H. Wyche* has been made metallurgical engineer, having been with the Rustless and Carnegie-Illinois Steel companies. *Robert Anibal* has been made analytical chemist. *Dr. Carl Curtis,* a ceramic specialist, has joined Titanium, while *J. S. Geiger* has been made research associate.

James J. Theodore returns to the engineering department of Pemco Corp., Baltimore, in charge of plant layout, while

WHY THE BIG 8 TOOL STEELS

should be in every shop

They will do more than 90% of the jobs requiring tool steels.

This is fact, not fiction. The tool room that stocks Bethlehem's Big 8 is ready to tackle the entire range of tool-steel applications.

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There's nothing "touchy" about the heat-treating of any steel in the Big 8 assortment. There isn't a prima donna in the lot.

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(maximum shock-resistance, hot work)
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(high-production die steel)
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(maximum red-hardness in hot work)
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A minute saved is a minute earned, especially in these times. Bethlehem's Big 8 will save you many minutes, many dollars, many headaches. If you're interested in simplifying tool-room practices, get the full story from the nearest Bethlehem distributor.

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- In production welding, which means working on top, bottom and on all sides of the weldment, a "Quick Change" of position is necessary for greater time saving, greater efficiency, greater safety to men and materials, and with resulting LOWER COSTS. A C-F positioner will do all this at the press of a button, without crane help or handling crews—it will rotate a full 360° at variable speeds from 0 R.P.M. up, tilt to 135° beyond horizontal, and permits welding, downhand, all sides, surfaces and angles in the one set-up with larger rods and fewer passes. All C-F positioners are pedestal mounted for maximum floor and work space—all are adjustable for height.

Write for Bulletin WP-22

CULLEN-FRIESTEDT CO.
1314 South Kilbourn Avenue Chicago 23, Ill.

Capt. Jimmy Willis becomes actively associated with the research and engineering division.

Donald J. Reese, with the Steel Div., WPB, since April, 1942, has rejoined the development and research division of the International Nickel Co., Inc.

E. J. Kelley has been promoted to vice president in charge of engineering of Skilsaw, Inc., Chicago.

Briefs on Associations, Promotions and Education

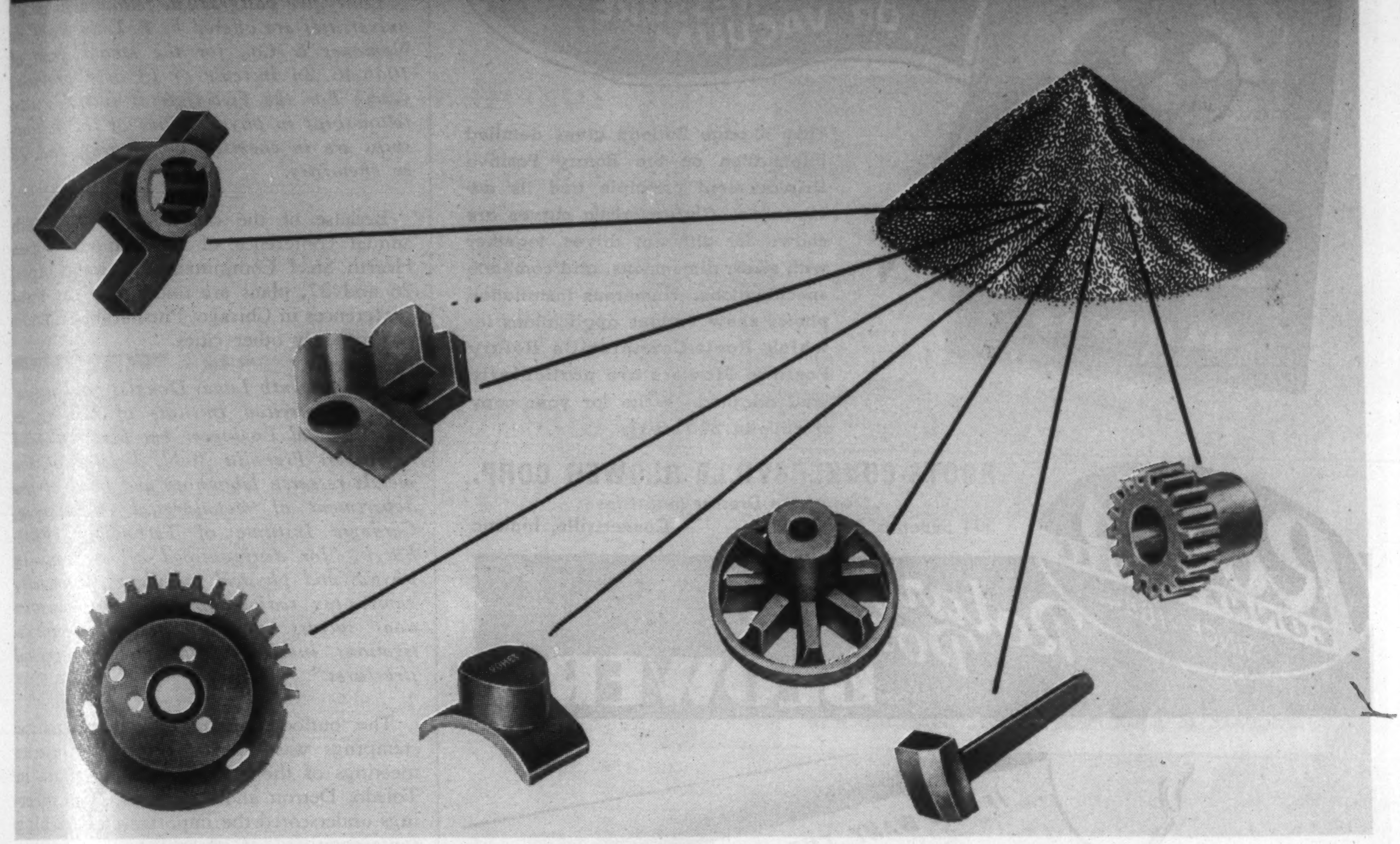
Perhaps the most plaintive cry from a trade association because of the O.D.T. ban on convention travel comes from the American Ceramic Society, Inc., whose president laments: "The cancellation of the 47th annual meeting is a much more serious problem for the society than many members realize, because the annual meetings provide the bulk of material for our publications. We must, therefore, meet by mail." The president thereupon lists nine "musts" to keep up research, dissemination of know how, etc. Meanwhile, the secretary suggests: "It is possible that transportation restrictions will be lifted sometime this spring."

The Detroit Spectrographer's Society is a new organization that had its first meeting in late January. Its purpose is to disseminate knowledge pertaining to spectro-chemical analyses and help develop improved methods and techniques. The chairman is William Edgar, Federal Mogul Corp., Detroit, while the secretary is Jess Toth, Harry W. Dietert Co., 9330 Roselawn Ave., Detroit 4.

The Steel Kitchen Cabinet Institute mentions the contemplated entry of a considerable number of newcomers in the field after the war. All such will be given a 16-page pamphlet on "Quality Standards for Steel Kitchen Cabinets," outlining all tests which such cabinets must undergo satisfactorily to win the Institute's seal of approval.

Nine distinguished engineers and industrialists have been given a new honor award for "notable achievement" by the Alumni Association of Stevens Institute of Technology. They are: John V. B. Duer, chief electrical engineer, Pennsylvania Railroad, Philadelphia, Pa.; John C. Hegeman, president, Hegeman-Harris Co., Inc., of New York; Henry C. Meyer, Jr., president, Meyer, Strong & Jones, Inc., of New York; William G. Mixer, superintendent of foundries, Buick Motor Div., General Motors Corp., Flint, Mich.; Auguste G. Pratt, president, the Babcock & Wilcox Co., of New York; Philip D. Wagoner, president, Underwood-Elliott Co., of New York; Harry T. Woolson, president, Chrysler Institute of Engineering, Highland Park, Mich; Edward W. Isom, vice president, Sinclair Refining Co., and president, Sinclair Rubber, Inc., of New York; and Raymond R. Machlett, president, Machlett Laboratories, Inc., Springdale, Conn.

POMET POWDER METALLURGY



. . . powder to parts in three steps

Think what Pomet Powder Metallurgy can mean to a manufacturer rushing to get peace-time products on the market!

He can get many types of small parts quicker and cheaper.

He can have volume with quality—close tolerances, density, ductility—and many other desirable characteristics *to order.*

And he can be sure of the same type of precision manufacturing that is now meeting rigid Army and Navy specifications.

By doing many intricate and accurate jobs quicker, Pomet Powder Metallurgy has earned the right to be called one of the big bottleneck busters of this war. Parts are made with little or no machining in three operations: 1. They are compacted from powder in a single stroke on powerful presses. 2. They are sintered in ovens at controlled temperatures. 3. Lastly they are coined to increase dimensional accuracy.

If you are interested in the quantity production of small parts of bronze, brass, iron, steel and other metals or special alloys, it will pay you to learn more about Pomet Powder Metallurgy. Write for complete information.

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A study of gases and other factors affecting the soundness of castings made from copper-base alloys has been instituted in the process metallurgy laboratories of Battelle Memorial Institute, Columbus. The research is under the auspices of the Non-ferrous Ingot Metal Institute.

Thirty-five postgraduate fellowships at 29 universities are offered by E. I. du Pont de Nemours & Co., for the school year of 1945-46, an increase of 13 over previous years. For the first time it includes two fellowships in physics. Five of the fellowships are in chemical engineering and 28 in chemistry.

Because of the cancelling of the 28th annual conference of the National Open Hearth Steel Committee at Chicago April 26 and 27, plans are under way for local conferences in Chicago, Pittsburgh, St. Louis and possibly other cities.

The sixteenth James Douglas gold medal of the American Institute of Mining & Metallurgical Engineers has been awarded to Robert Franklin Mehl, director of the metals research laboratory and head of the department of metallurgical engineering, Carnegie Institute of Technology, Pittsburgh, "for distinguished achievement in physics and physical metallurgy, especially gamma-ray radiography, and for conspicuous success in his metallurgical investigations involving diffusion and crystal structures."

The outlook for post-war markets for stampings was discussed at recent district meetings of the Pressed Metal Institute in Toledo, Detroit and Worcester. The meetings underscored the importance of training representatives of stamping concerns to serve their customers as "product engineers" so that they can help solve design and production problems.

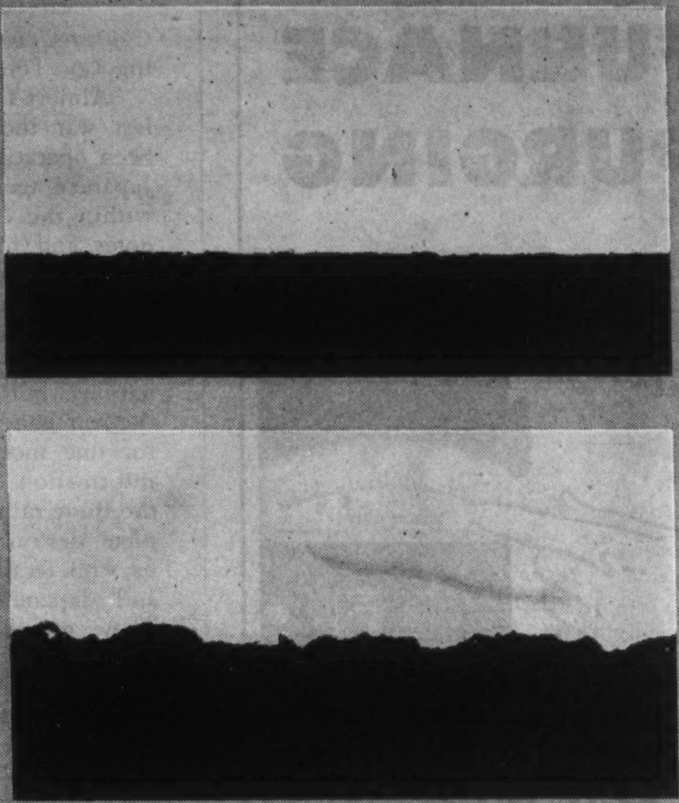
The first Midwest award of the American Chemical Society has gone to Dr. Lucas P. Kyrides, research director, Organic Chemicals Div., Monsanto Chemical Co. The award, a gold medallion, is to be given each year by the Society's St. Louis section. He pioneered synthetic rubber substitutes, and has been called the "American father of synthetic rubber."

Meetings and Expositions

Instead of the NATIONAL Open Hearth Conference, which was to be held in April, the following LOCAL conferences on open hearth steel are scheduled to be held:—

Philadelphia	April 20, 1945
Chicago	April 27, 1945
St. Louis	May 4, 1945
Pittsburgh	May 18, 1945

here's why Ferrisul is used prior to drawing galvanizing or painting steel...



Photomicrographs, magnification 250:1. Above, unetched surface of SAE 1010 steel. Below, Ferrisul etched surface same steel. Etching by solution containing 10% Ferrisul, at 70°F. for 120 seconds. "Etch teeth" are shown to be .000375″ high. Weight loss was .0104 lbs. per sq. ft. of area which corresponded to a calculated average penetration of .000258″.

Those microscopic hills and valleys you see in the lower photomicrograph . . . etched there with Ferrisul . . . have functions important in three different handlings of steel:

1. Galvanizing. The light, evenly etched steel provided by Ferrisul treatment is preferable to a smooth, unetched surface because it gives the zinc coat a tooth to cling to . . . lessens the tendency of the coating to peel when the metal is bent or flexed.*

2. Drawing. A pre-etched surface provides space for the distribution and retention of lubricating agents during the draw. These lubricants, carried into the die, prevent scuffing of the finished surface, also reduce friction, lengthen the life of the die, and cut down the power required for the draw.

3. Painting or Lacquering. Preliminary investigations indicate that this same etched tooth, provided by Ferrisul, produces a far better base for painting or lacquering than a smooth, shiny surface.

Ferrisul, Monsanto's anhydrous ferric sulfate, is preferred for all three of these uses because: its action on steel is *rapid* (often 30 times faster than sulfuric acid), it does not liberate hydrogen and create consequent danger of embrittlement of steel; it has no acid fumes, and is easy and safe to use and store.

For full information on Ferrisul for metal treatments, write, wire or phone: MONSANTO CHEMICAL COMPANY, Merrimac Division, Everett Station, Boston 49, Massachusetts.

* * *

*Monsanto's research laboratories, working in close co-operation with industrial galvanizers, have developed valuable information on this work, especially on the optimum amounts of etch for ideal galvanizing . . . and are in a position to give assistance to galvanizers in adopting the use of Ferrisul.

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SPECIFIC GRAVITY
SAFER!

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Ranarex is a sturdy instrument, containing no chemicals or fragile parts, easy to operate. Write for free bulletin to The Permutit Co., Dept. A17, 330 W. 42nd St., New York 18, N. Y. or Permutit Company of Canada, Ltd., Montreal. *Trademark Reg. U. S. Pat. Off.

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House Organ Notes

Copper Commando, Anaconda Copper Mining Co. Feb. 16, 1945.

"Almost from the time of the end of the last war the spy system of Germany has been operating. It is not many years since Japanese agents visited the Butte mines and within the eyesight of many people made notes and took pictures. This country in those days operated in a spirit of friendliness with the nations we are now fighting. It is now clear that these operations were intended, not as friendly gestures of friendly nations, but as data-gathering trips. Had the war gone favorably for the Axis powers for one more year, it is certain that the information gathered in connection with the Butte mines could have meant their complete destruction. There are those among us who recall the 'friendly' visits of Nazis and Japanese at the Anaconda smelter. They, too, took down many notes, drew sketches and took photographs. The same procedure occurred at Great Falls. One cannot fail to see to what uses this information might have been put."

The Bellringer, Bell Aircraft Corp., February, 1945.

"Blowing bubbles is an exact science in making eyes for B-29's at Bell bomber plant. Bubbles are blown of transparent plastic on compressed air machines by alert operators who pay strict attention to proper timing because these bubbles become sighting blisters for gunners on bombers. There must not be the slightest scratch or defect. The plastic comes in laminated flat sheets with appearance and hardness of plate glass. They are cut to desired shape, usually circles, by band saw. They are heated in an oven until soft and pliable, at this point handled with gloves and quickly transferred to a forming machine. The operator immediately applies just the right amount of air pressure to raise a perfect bubble. Stretched across the top of the forming machine is a white string to guide the operator as to correct height for the blister. When the bubble reaches correct size and shape, it must be held here until the plastic cools and hardens. Women blow these bubbles, and are highly skilled."

Nassau, Nassau Smelting & Refining Co., February, 1945.

"If the present experimentation of the Louisville and Nashville fuel conservation laboratory is successfully expanded, maybe all jokes about Pittsburgh will stop. For switch engines on this road have been burning thousands of tons of soft coal without the usual clouds of black smoke. It's a question of getting the right mixture of air and gas for complete combustion, as in an auto carburetor. We put three air intakes on each side of the engine. Boiler steam rushes through and draws air into the firebox through jets the size of pencils, staggered to make a swirling mixture of oxygen with coal gases."

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Permanent position open with industrial furnace company for an experienced furnace designer. Knowledge of mechanical handling and quenching equipment of particular value. Ideal working conditions; generous pension plan; opportunity and salary commensurate with ability. Submit all details: education, experience, salary and photograph in first letter. Ajax Electric Co., Inc., Frankford Ave. at Delaware Ave., Philadelphia 23, Pa.

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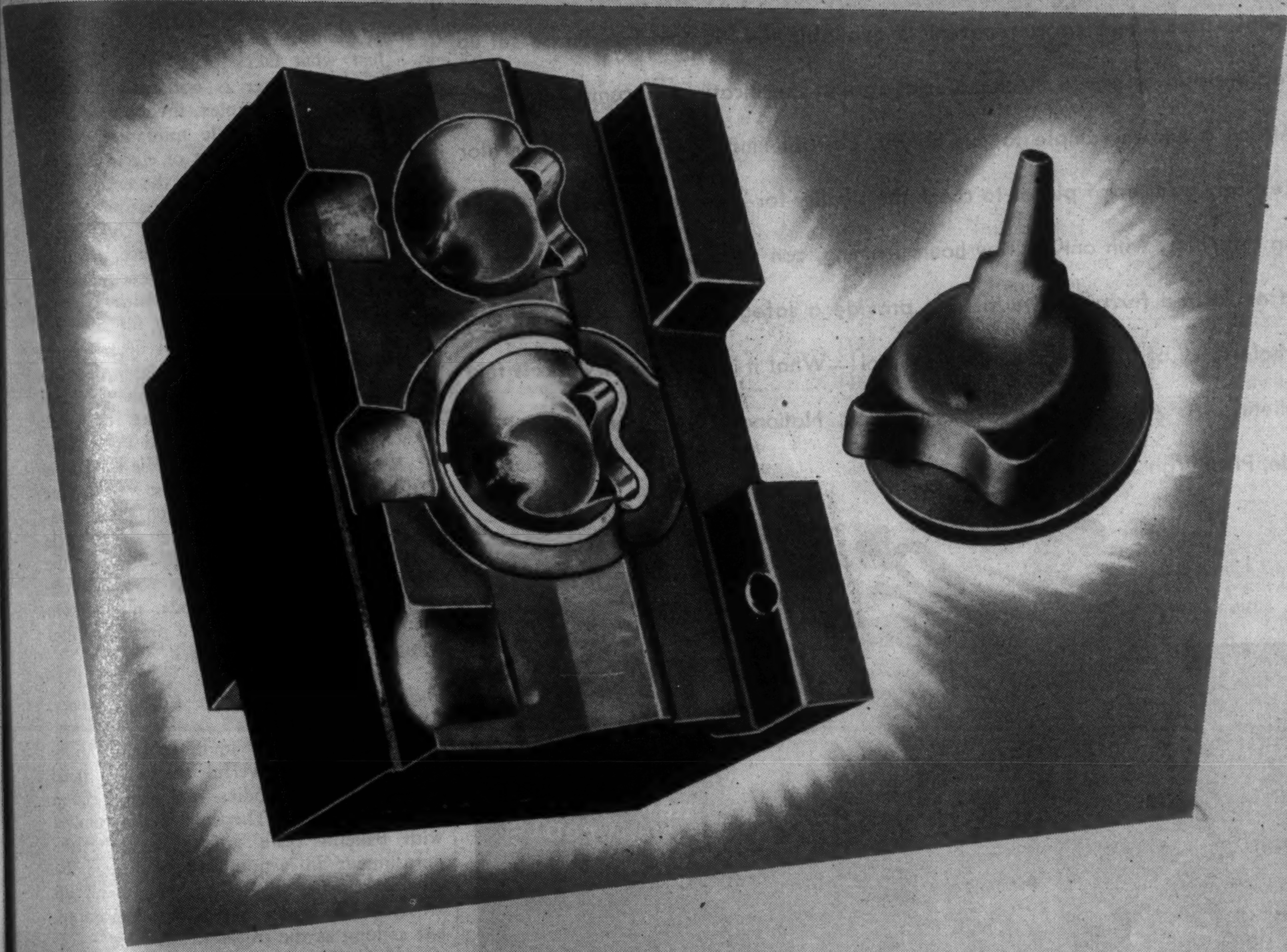

Time is an element of cost, and the time it takes to machine and finish a forging is an element of its cost at the point of assembly.

Check your forging costs at the point of assembly with a T & W Forging Engineer.

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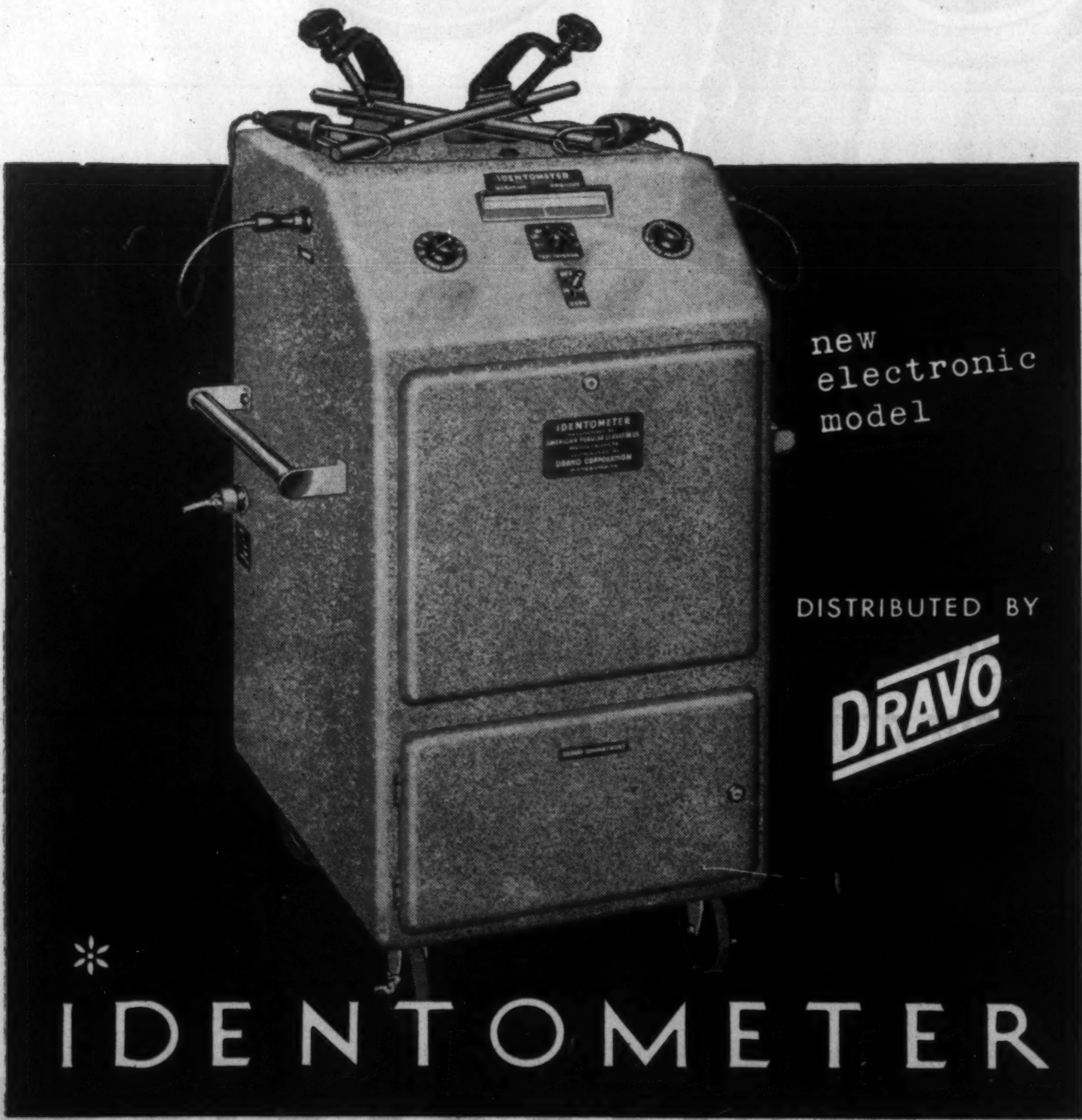
Attach a known sample to this handy, portable instrument and the operator can test any number of pieces to check the quality for accurate control.

An operator, with only a few hours training, can use Identometer to test most rolled or forged ferrous material and provide a safeguard against error. Read the whole story of this new metallurgical tool!—What it is and how it works is told in Bulletin 4A. Address—Dravo Corporation, National Department, 300 Penn Avenue, Pittsburgh 22, Pa.



AN ELECTRICAL INSTRUMENT FOR THE INSTANT AND ACCURATE IDENTIFICATION OF MOST ROLLED OR FORGED FERROUS ALLOYS BY THE USE OF REFERENCE SPECIMENS

The Aluminator, Lafayette Works, Aluminum Co. of America, March 2, 1945.

"Try this trick. Fill an ordinary glass tumbler full of water—right up to the top. Take a handful of nails, about 4 penny size, and begin dropping them point first into the glass. Ask the others how many they think you can drop in without spilling the water. Some will say two or three—some ten. But each nail displaces only an infinitely small quantity. So the answer is 50 or 60—or even 100 if you are careful."

Silicate P's & Q's, Philadelphia Quartz Co., Third Month, 1945.

"Just what takes place when metal is corroded by water is not perfectly clear. The reaction is complex, involving the formation of innumerable miniature electrolytic cells with a transfer of electrons. The attack may be general over the entire metal surface, resulting in a soft coating of iron rust, or it may be more local. Starting at slight imperfections in the surface, the metal is dissolved away and then reprecipitated to form hard-walled tubercles which grow as corrosion proceeds until they fill the pipe just as hard water scale will do, only the tubercles have a soft center; shocks such as a mild water-hammer or a suddenly closed valve will break them, resulting in a rush of red water from the released iron oxide. If the tubercle is old and the corrosion within has been proceeding for a long time the metal wall may have been eaten completely through and then, when the tubercle is finally broken, a leak appears and the pipe must be replaced. A corrosion inhibitor, such as silicate of soda, migrates to the metal walls and forms a protective film which insulates against attack."

Bakelite Review, Bakelite Corp., January, 1945.

"The mechanized mules of the U. S. Army—rugged, powerful trucks equipped with wood cargo bodies—are seeing action in all war theaters. The wood bodies, bonded with Bakelite resin glues, receive terrific punishment in action, are unaffected by diverse climates and salt water, stand up satisfactorily under constant overloading, last as long as the trucks themselves."

Mechanical Topics, International Nickel Co., Inc., Vol. 8, No. 1.

"Engineers of one aircraft company found that by using Monel rivets they reduced the weight of aircraft structures by 16½ lb. per joint. Its high strength and resistance to corrosion permits use of thinner rivet bodies and lighter heads, effecting a substantial weight saving in the 400,000 rivets in a big bomber."

The Mainspring, Wallace Barnes Co., February, 1945.

The following is an excerpt from a writing by the famous military commentator, Major George Fielding Eliot. "I work a great deal with maps. It is the location of the infantry that makes the map important. It is the holding or taking of ground that really matters. And that means—infantry: Muddy, lousy, unshaven, tired, foot-slogging infantry. If our infantry can advance, we're winning; only when they retire can we be said to be losing. And that isn't often. Remember the little black line on the map. That's the yardstick of victory or defeat."

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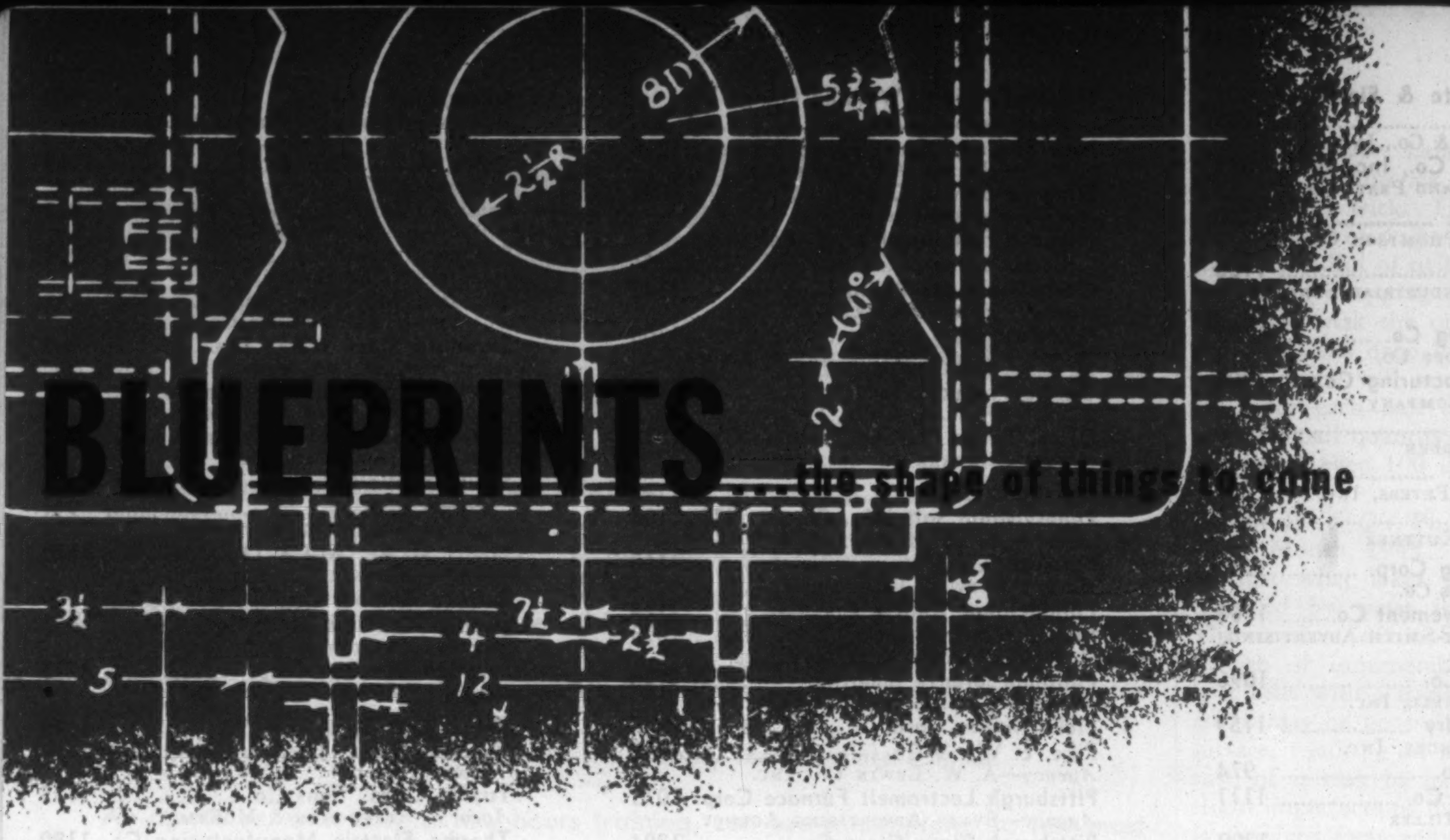

BLUEPRINTS ... the shape of things to come

Reconversion Period

The shock of reconversion may not be quite so violent as many of us fear, if we are to credit a recent N.A.M. survey. 89% of the manufacturers quizzed can be fully reconverted within 4 weeks, and even at the lowest reconversion-employment level the national labor force will be higher than the 1939 total of 10,600,000. Virtually all retooling-unemployment will be eliminated in 16 weeks. Automobile, aircraft and parts, machine tool, and iron and steel manufacturers will be hardest and longest hit, employment-wise, with approximately 1 million employees out of work for about a month in all those industries taken as a group.

West Coast Steel

The new steel mills at Fontana and Geneva, however they may be regarded by many disinterested prognosticators, are far from "white elephants" in the eyes of their present operators, both of whom have indicated their intention of purchasing their respective plants from the Government if possible. The U. S. Steel Corp. has cast longing glances at Fontana in addition, but Mr. Kaiser says he wants to keep it.

Agricultural Machinery

Farming around the world will be mechanized after the war, and this country's farm machinery industry may look toward a record boom in the domestic and international market for its products. Sales may be more than one billion dollars annually in the opinion of one automobile executive whose company is developing a new line of post-war farm machinery.

Passenger Train Design

Discomforts of train travel today will be atoned for in the post-war period. Better insulation, air conditioning, less car sway at high speeds, no jolting, etc. will be the rules rather than the exceptions. For the playboy type there will be a combination bar-lounge car, which at night can be transformed into a 9 x 20 ft. dance floor, while in the rear half of the car movies are projected on a screen. So, why travel abroad? See America first and keep your money within the country—that is if you have any left!

Tin Plate

When tin supplies become normal there will be a shift of food packs back to hot-dipped tin plate, according to one authority in the can field. He reports studies indicating that electrotinplate lacks the desired uniformity. But electro has advantages, too, so it looks like a merry battle!

Polystyrene Plastics

Large-scale production facilities for styrene, built as a part of the synthetic rubber program, will give plastics based upon this material a head start in the post-war competition among non-metallic engineering materials. The properties of the polystyrenes—transparency, range of colors, good dimensional stability, good resistance to chemicals and water, excellent electrical insulating properties, and ease of molding by injection or extrusion methods—have already brought applications for refrigerator parts, caps for chemical reagent bottles, electrical insulators (especially in high frequency work), lighting fixtures, aircraft panels, etc.

Precision-Cast Magnets

Alnico magnets, conventionally made either by casting and grinding or by powder metallurgy methods, have successfully been fabricated by the precision ("lost-wax") casting method, with marked production, economic and technical-quality advantages. Looks like another post-war market for this fast-growing process!

All-Resin Slide Rules

Slide rules, drawing instruments, engineers and architects' scales, etc. are now being injection-molded of methyl-methacrylate resin, where they were formerly made of seasoned boxwood or boxwood faced with cellulose nitrate. Molding holds tolerances on a 5-inch slide rule closer than 0.0005 in. between scales. The advantages that make this material and method a likely candidate for post-war success are the elimination of the 2-3 yrs. seasoning period, the humidity resistance and greater graduation-life of the molded resin rules.

Building Boom

The residential building field, normally an active market for fabricated materials and parts, has been depressed to a low level by the war. But house-building will represent one of our biggest post-war booms; the "unfilled demand" is estimated at 1 million dwelling-units per year for several years after the war, or upwards of $6 billion per year. Total building construction is expected to average $10 billion per year for ten years after victory in Europe.

Lighting and Tungsten

Eventual replacement of incandescent lighting, using the tungsten filament, by fluorescent lighting has been predicted, the latter industry reaching a production value of $250 million in 1942 (but a consumption value of only $25 million). Even the complete abandonment of the tungsten lamp filament, however, would not seriously affect the tungsten market, for only 1½% of the tungsten output normally goes into filaments while 95% goes into alloy steels, nonferrous alloys and tungsten carbides.

Zinc Alloy Dies

Recent developments in the use of zinc alloy dies for stamping, blanking and forming light sheet metal point to much wider post-war use than just the aircraft industry, where it all started. The dies have proven successful for some long-run as well as short-run jobs, and through plaster-molding techniques can now be made to tolerances down to ±0.0015 in.